CIVIL ENGINEERING

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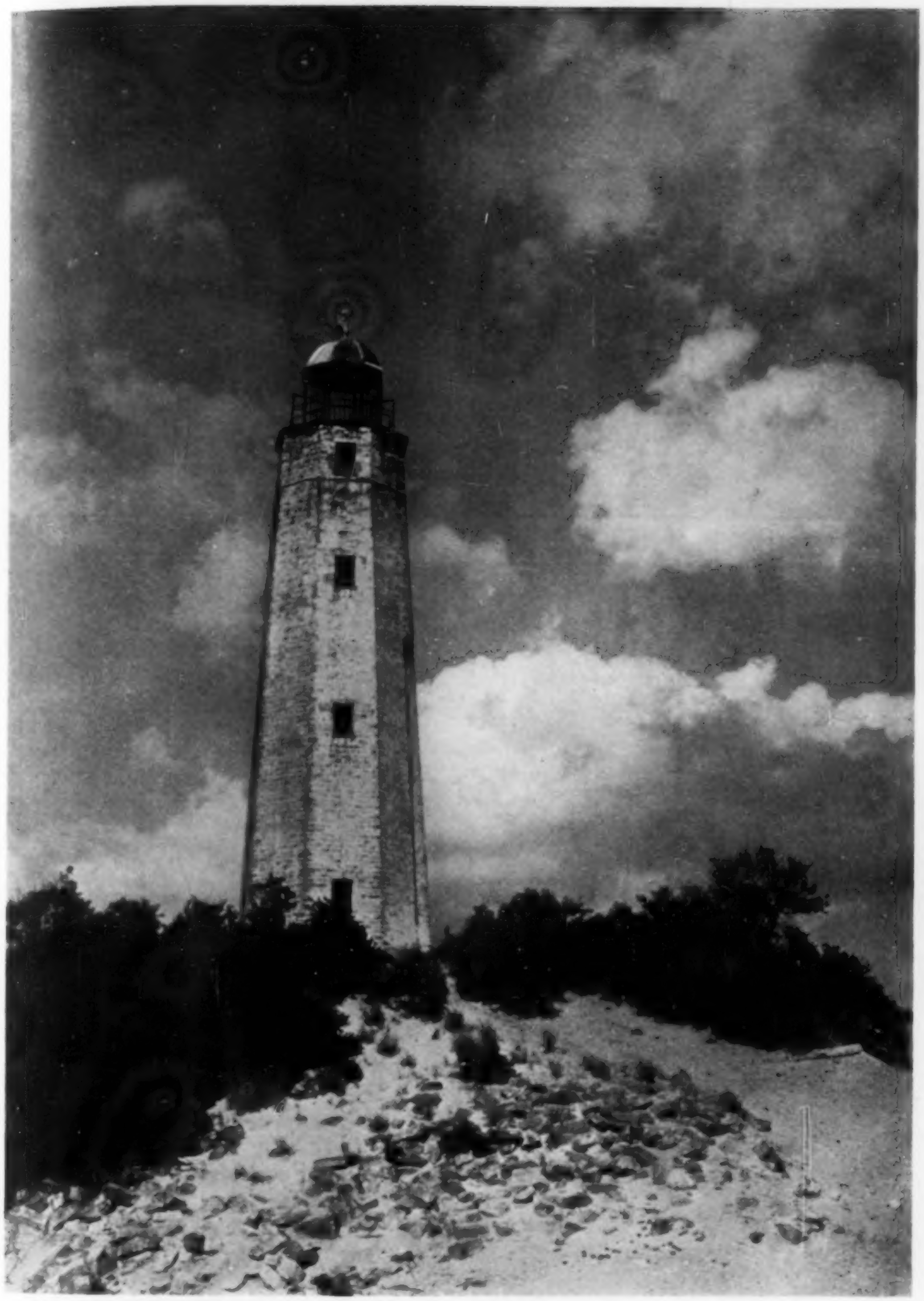
LOWER MANHATTAN FROM GOVERNOR'S ISLAND

Volume 1 — AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852 — *Number 6*

MARCH 1931



Old Light-house, Cape Henry, Virginia

Norfolk is next!

NORFOLK is the rendezvous for the Society's Spring Meeting, to be held April 15–17. Near Norfolk stands this old lighthouse which was built in 1792, the first erected by the Federal Government. It marks the spot where English settlers in Captain John Smith's party landed before proceeding to Jamestown to establish the first permanent English settlement in America.

Among Our Writers

H. G. BALCOM has designed many of the world's great buildings, including the Grand Central Terminal and Empire State buildings in New York, and the Louvain Library in Belgium.

H. V. SPURR's early experience was on the design of heavy railroad bridges. He is the author of a recent book, *Wind Bracing—The Importance of Rigidity in High Towers.*

C. R. YOUNG, Professor of Civil Engineering at the University of Toronto, combines his teaching career with a consulting engineering practice.

G. G. WHEAT's experience, comprising 25 years of work on drainage, railroad, municipal, industrial plant, and shipyard projects, has been varied. He is considered an expert in handling building materials.

GEORGE K. BURGESS has, since 1903, been connected with the National Bureau of Standards, where he has served in varying capacities.

RAYMOND S. PATTON has been connected with the U.S. Coast and Geodetic Survey for over a quarter of a century.

JULIAN D. SEARS, since his graduation from Johns Hopkins, has done extensive coal and oil research in the West for the U.S. Geological Survey.

THOMAS H. MACDONALD has been largely instrumental in building up in Iowa one of the best highway systems in the United States.

S. H. MCCRORY, has been engaged in drainage investigations for the Government for almost 25 years.

GEN. LYTLE BROWN, a graduate from West Point in 1898, was in charge of the construction of Wilson Dam.

C. J. TILDEN has alternated the teaching of engineering in several universities with work for the New York Rapid Transit Commission. He has been at Yale University since 1919.

R. W. CRUM, Director of the Highway Research Board of the National Research Council, has done a great deal of work with materials and testing for the Iowa Highway Commission.

G. I. RHODES began his career as Electrical Engineer with the Interboro Rapid Transit Company, of New York.

JOHN P. HOGAN has served in an engineering capacity on such important projects as the construction of the Catskill Aqueduct.

R. F. EWALD has specialized in hydraulic engineering, having been designing draftsman on such water-power projects as the Chicago Drainage Canal and the Lake Utah storage reservoir.

MORRIS KNOWLES has been the president of the engineering firm bearing his name since 1903. His office has handled the investigation, design, and construction of a large number of sanitary systems, water supply projects, municipal developments, and community plans.

LT.-COL. U. S. GRANT, 3d, following the career of his distinguished forbear, graduated from the U.S. Military Academy in 1903. He has served with distinction in the Philippines, on the Mexican Border, and in France.

WILSON T. BALLARD has had wide experience in investigational work on public utilities, railroads, and industrial properties in Philadelphia and Baltimore.

VOLUME 1 NUMBER 6

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VOLUME 1 — MARCH 1931 — NUMBER 6

New York's Tallest Skyscraper

Structural Features of the Empire State Building

By H. G. BALCOM
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSULTING ENGINEER, NEW YORK, N.Y.

SINCE the dawn of civilization it has ever been the dream of man to build lofty structures. In ancient times, this was exemplified in the building of the Hanging Gardens of Babylon, the Colossus of Rhodes, and the Pyramids of Egypt. In medieval times, and until the latter part of the last century, the building of the great cathedrals of the old world marked the highest achievement in building construction. All of these structures were limited by the materials then available for use. Within the last thirty years, however, the development of structural steel has opened a field of almost unlimited possibilities and has led to the construction of buildings that surpass in height anything before attained. The most recent of these great structures is the Empire State Building.

At the Seventy-Eighth Annual Meeting of the Society in New York, members of the Structural Division were privileged to hear, on January 22, a description of this gigantic effort of man to pierce the sky. Mr. Balcom's experience with the structural design of many of New York's taller skyscrapers adds interest to the following abstract of his paper. During the meeting nearly five hundred engineers accepted the invitation to inspect this structure, now nearing completion.

THE Empire State Building, which is today the highest structure in the world, rises to a height of 1,250 ft. above the street level, and surpasses any other building in height by about 200 ft., being 266 ft. higher than the Eiffel Tower, which for many years was the tallest structure ever erected. A mooring mast for dirigibles forms the upper 200 ft. of this monumental building. Relative proportions and heights of structures that have been outstanding are shown in Fig. 1.

VALUABLE RESULTS OF COOPERATION

Recognizing the prime importance of wind bracing in a building of this height, the architects, Messrs. Shreve, Lamb, and Harmon, of New York, worked in close harmony with the engineers, with the result that very excellent conditions were provided, practically all the columns being wind braced in each direction on the center line. The fact that the lot was large and rectangular also assisted greatly in the achievement of favorable results.

The building exemplifies the fact that good construction and good architecture can go hand in hand if sympathetic cooperation exists between the architect and the engineer. Such cooperation is, in fact, of the utmost importance in producing satisfactory results; and, as architects are giving this subject more and more attention, it is of first importance that structural engineers render constructive assistance in this field. They must, however, remember that at times architectural requirements are of more importance than extreme simplicity of construction.

THE EMPIRE STATE BUILDING

About November 15, 1929, the architectural plans for the Empire State Building were sufficiently advanced so that the structural design could be started. For renting purposes, it was necessary to have the building ready for occupancy by May 1, 1931, and the builders, Starrett Brothers and Eken, by scheduling their work, found that they required the completion of steel erection in September 1930. This did not give them sufficient time to prepare complete steel plans and send them out for bids in the regular manner.

After a general consultation, typical plans and specifications were prepared and a contract was negotiated for furnishing and erecting the 50,000 tons of struc-

tural steelwork. This contract, based on the use of Carnegie broad-flange sections, enabled the design and other features to progress from the bottom to the top of the building in time to permit the fabrication and erection of the steelwork, in accordance with schedule, in September.

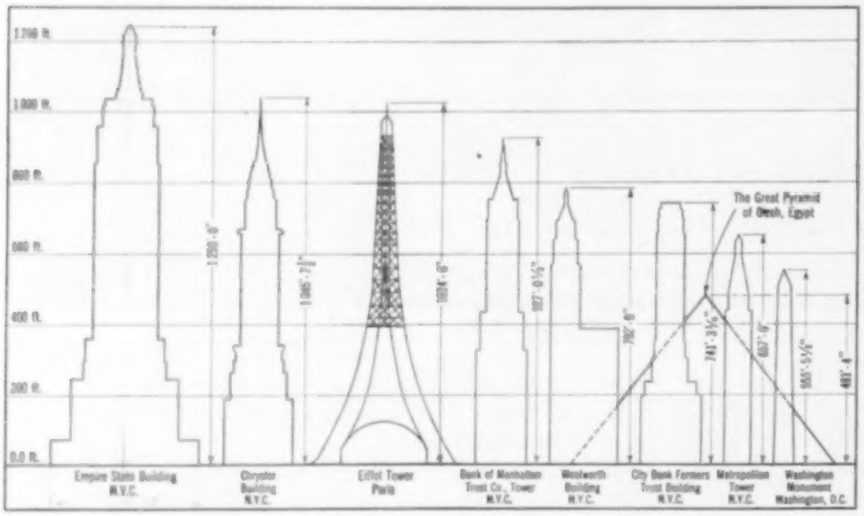


FIG. 1. COMPARATIVE PROFILES OF VARIOUS STRUCTURES

PLAN OF THE WORK

A detailed schedule, by tiers of steel, was prepared and is shown graphically in Fig. 2. On it are given the dates for furnishing information and for ordering material, as well as for the completion of the shop drawings, of the fabrication, and of the steel erection. Although these dates were not adhered to literally, there was but small variation. The picture of the steelwork, taken on June 9, 1930, shows the progress made in a little more than two months' time. During this period, nearly 30,000 tons of steel had been set in place, and this, to the best of my knowledge, establishes a record for speed of erection on a single building. Everyone concerned cooperated to the fullest extent, with the result that the erection of the steelwork for the main building, not including the mooring mast, was completed in about ten months from the time the steel design was started. This part of the building is, in itself, nearly as high as any structure ever built.

The plot was ideal for a building of record height; its size and shape enabled the architects to plan a tower that would be economic in construction and yet provide enough elevators to give the frequency service necessary for satisfactory occupancy. Then, too, the foundations were not only adequate, but rock was found at a depth which made them very economical. In designing the building, the basement plan was arranged to correspond as nearly as possible with the existing excavated space, thus reducing excavation to a minimum.

In considering the Empire State Building, it is of interest to compare it with other structures which have been outstanding in size. Data for such a comparison with six other buildings are given in Table I, from which it can be seen that the Empire State Building exceeds them not only in height but in cube and floor area. It is of interest, however, to note that, based on the lot size, there is a greater percentage of floor area in the Equitable Building than in any of the others. This is due to the fact that it was erected before the present zoning laws were in effect and before setbacks were required.

Some idea can be formed of the size of the Empire State Building when it is considered that it has about 63 acres of floor space. One-story buildings to supply this same amount of space would cover every block from Fifth Avenue to Sixth Avenue, and from 34th Street to 49th Street. To transport the steel in the building would require a train 11 miles long, while one 57 miles in length would be necessary to carry all of the materials used.

COLUMNS FOUNDED ON ROCK

All piers for columns throughout the building are of concrete carried to solid rock. The Building Department permitted a maximum pressure of 500 lb. per sq. in. on the rock and the same pressure on 1:2:4 concrete. However, as it was desired to keep the grillages as small as possible, they were designed on the basis of a pressure of 600 lb. per sq. in. To conform with the building code, this required the use of $1:1^1/_2:3$ concrete, which was employed for all low piers and for the top of the high piers. As it was necessary to carry the concrete beyond the edge of the grillage beams, the lower portion of the high piers was not stressed to exceed 500 lb. per sq. in., the top layer of $1:1^1/_2:3$ concrete being used to distribute the pressure from the grillages to the pier shaft below.

Two main types of column bases were used. Where the column load did not exceed 2,600 kips (1 kip = 1,000-lb. unit) a heavy rolled steel billet was employed, bearing directly on the concrete. For heavier loads, which in all cases exceeded 4,500 kips, the column cover plates were cut at a point 4 ft. or more above the base, and wing plates of the same thickness as the covers were

TABLE I. COMPARATIVE QUANTITIES FOR SEVERAL LARGE BUILDINGS IN NEW YORK

NAME OF BUILDING	TOTAL CUBE, IN CU. FT.	GROSS FL. AREA, IN SQ. FT.	GROUND FL. AREA, IN SQ. FT.	HEIGHT IN FT. ABOVE GRADE	NUMBER OF RENTABLE FLOORS	TOTAL WEIGHT OF BUILDING IN TONS	TOTAL LOAD ON HEAVIEST COL. IN KIPS
Empire State	35,613,970	2,754,180	83,860	1,250 ft. 0 in.	86	302,500	10,340
New York Central	16,179,700	1,198,450	66,417	537 ft. 0 in.	33	131,602	5,762 Superstr.
Lincoln	14,217,130	1,154,490	43,765	673 ft. 0 in.	56	118,253	4,681
Chrysler	14,200,000	1,100,000	37,555	1,045 ft. $7^1/_2$ in.	70	111,786	7,126
City Bank Farmers Trust	10,815,000	850,780	24,000	741 ft. $3^1/_8$ in.	59	136,160	8,574
Graybar	16,014,000	1,041,000	68,395	391 ft. 11 in.	32	144,954	5,541
Equitable	24,300,000	1,926,060	49,972	541 ft. 10 in.	42	192,343	5,271

spliced in with milled joints in order to spread the load to the billet and grillage beams. The billets were so designed that the pressure on the webs of the grillage beams would not exceed 18,000 lb. per sq. in. The heaviest column base of each type is shown in Fig. 3. On the west lot line, where grillage beams were used, there are a few columns with the loads spread from the column shaft to the beams by means of billets only, without any wing plates. This type was employed instead of the billets alone on account of the necessity for narrow widths so as not to project beyond the lot line.

The steel column types used are shown in Fig. 4. Each series has for the central core the heaviest rolled section, that is, a Carnegie H-column, 14 in. by 425 lb., with cover plates, webs, and angles added until the required cross-sectional area was obtained. Columns in the Empire State Building are among the largest used in any New York skyscraper. The largest columns were designed for loads of over 5,000 tons.

WIND BRACING PROVIDED

In accordance with the New York Building Code, wind bracing was designed to provide for a pressure

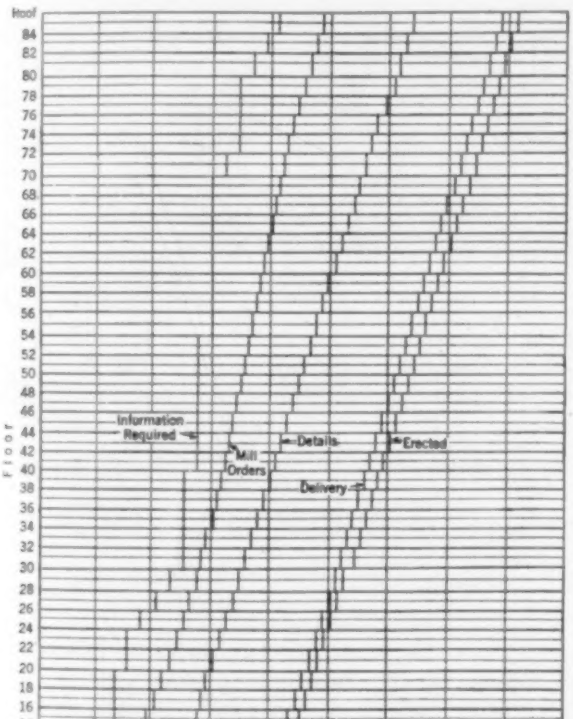


FIG. 2. STEEL ERECTION SCHEDULE

of 20 lb. per sq. ft. above the sixth-floor level. No wind was assumed below the 100-ft. level, practically at the sixth floor. In addition to this, a horizontal force of 50 tons, applied at the top of the mooring mast, was used as the pull from a dirigible.

There has been a prevailing idea that the pull from a dirigible was a main factor to cope with in design-

TWO MONTHS AFTER STEEL ERECTION BEGAN
June 9, 1930—30,000 Tons in Place

ing the wind bracing for the building. Although the wind pressure on the mooring mast and the pull of a dirigible did produce quite a little effect on the design of the wind bracing near the top of the building, the effect was only about 7 per cent of the total wind pressure in a north and south direction. The total was 4,340,000 lb., of which 318,000 lb. were represented by the wind pressure on the mooring mast and the pull from a dirigible.

WIND CALCULATIONS

The problem of wind bracing was greatly simplified by the regularity of the building and the fact that but very few of the columns were offset or carried by girders. Its regularity and symmetry enabled the division of wind bracing by bents. In wind calculations, the floor construction was assumed to act as a rigid horizontal plate, which distributed the wind pressure to the various bents in the ratio of their resistance.

Overturning wind stresses were figured by the cantilever method. The resistance was based on the relative moments of inertia of the different bents, that is, the overturning unit pressure, positive or negative, taken by each column, was proportional to its distance from the center of gravity of the bents. Figure 6 shows the various north and south wind bents in the 24th story, just below the base of the tower.

Computed in this way, the various bents take the following percentages of wind shear: A = 9.05 per cent, B = 11.8 per cent, C = 12.5 per cent, D = 10.1 per cent, E = 5.5 per cent, and F = 1.05 per cent.

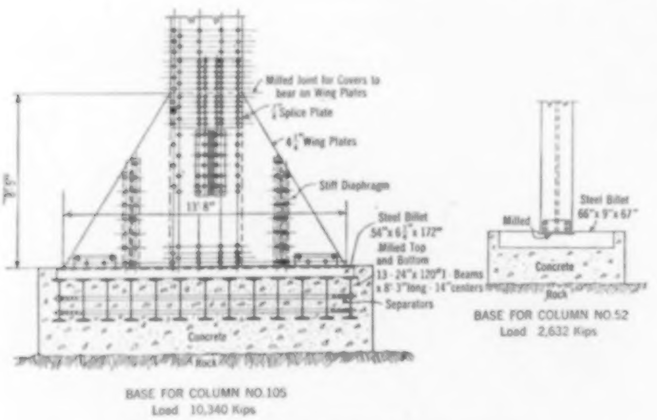


FIG. 3. TYPICAL COLUMN FOUNDATIONS

The total shear at this level is 3,074 kips, which produces shears on each of the bents as follows: A = 278 kips, B = 364 kips, C = 385 kips, D = 310 kips, E = 169 kips, and F = 32 kips. Calculations for the distribution of shears and bending moments in the various portal frames followed the regular procedure, which gave the strength of wind brackets required at each point. As all the computations for wind were based on the floor system acting as a rigid horizontal plate, each column must necessarily, under the action of wind, move the same horizontal distance (Fig. 6).

If a given column, due to its section or to a variation in the stiffness of the connecting portal beams, should be relatively much stiffer than other columns, it would necessarily take more than its share of the load and might readily be very much overstressed before the other columns took any considerable stress. Therefore, deflections for all the columns were computed and the floor framing was so adjusted that, under the computed load, they would all be as nearly equal as practicable.

SYSTEMS OF CONNECTION

For the connection of the portal beams to the columns two systems were employed. In the first, knee braces were used, and in the second the top and bottom flanges of the portal beams were connected to the columns by beam stubs or angles. In Figs. 5 and 6 are shown the location of the knee braces in the plan and the general arrangement in section. Where top and bottom connections were used, the general arrangement of the wind bracing is also shown.

Knee braces were employed adjacent to the elevators where they would not interfere with the interior architecture of the building. These provide for the heaviest connections and are generally a full story in depth, thus reducing the number of field rivets required and acting as a partial support for the beams, having the effect of shortening the span. In some cases, this permitted the use of smaller beams than would have been the case if no provision had been made for the wind.

Beams perpendicular to the webs of the columns do not connect to the column webs but directly to the cover plates. This forms a very satisfactory arrangement, as the connection is made to the part of the column which takes the major part of the bending, and the connecting rivets are in shear and not tension. For some of the lighter columns, the connections were made to the web. However, we have never had any reason to feel that rivets in tension were not perfectly satisfactory for wind bracing.

AUTOMATIC DEVICES WILL RECORD WIND PRESSURES AND STRESSES

There has been a great deal written on the subject of wind bracing but it has all been based on theory.

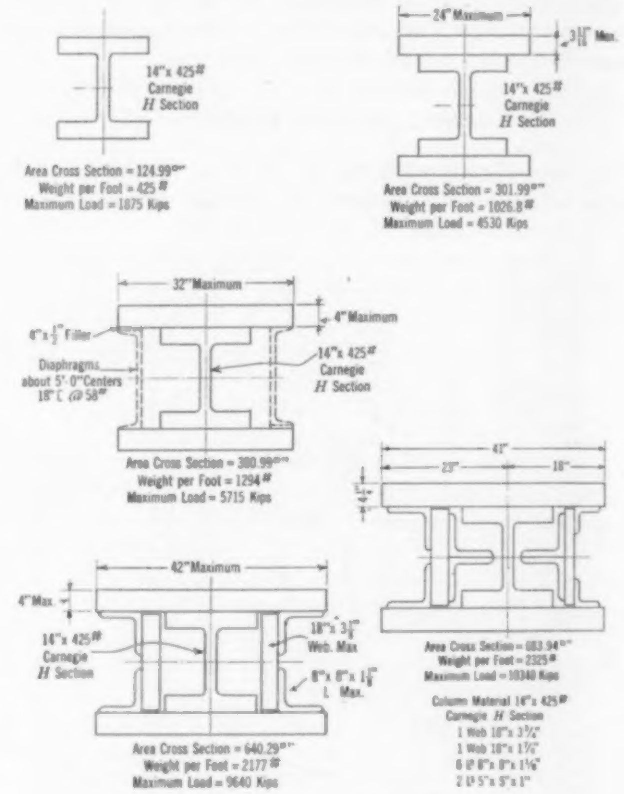


FIG. 4. COLUMN TYPES AND MAXIMUM SIZES

In every case the wind pressure has been assumed and the inertia of the building entirely ignored. Some wind bracing designs are being made in such a way that the different members do not act together and may produce excessive deflections, which, if not absolutely dangerous, may cause the building to be unsatisfactory for occupancy. It is much easier to safely design a building to resist wind than to design one for satisfactory occupancy, because there are very few data available concerning the effect of wind on high buildings, to enable the engineer to make a satisfactory and, at the same time, an economic design.

Through C. T. Morris, M. Am. Soc. C.E., of Ohio State University, the American Institute of Steel Construction has been studying the effect of wind on the American Insurance Union Building in Columbus, Ohio;

but the ratio of height to width is such that, under the winds that have occurred, negative results have been obtained. The fact that the Empire State Building is much slimmer than the American Insurance Union Building, plus the fact that the column arrangement is ideal for wind analysis, has persuaded the institute to provide for a series of tests to see if results cannot be secured which will throw more light on the subject of wind bracing.

A series of tubes, which has been installed from the outside walls at different levels and at different points on the floors, should give, by pressure-recording devices, a good idea of the wind pressures on the building, based on a given recorded velocity of wind. These tubes have been so located that the pressures can be measured on the windward side of the building, as can also the pull from the partial vacuum on the leeward side.

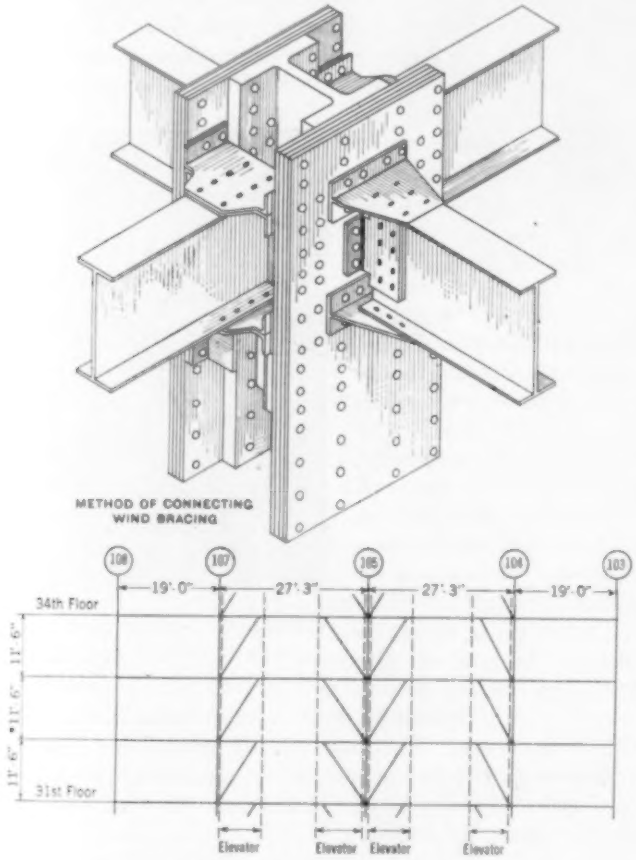


Fig. 5. Wind Bracing Details
Above, Wind Bracing Connected to Column Cover Plates
Below, Typical Knee Bracing Located in Elevated Shaft

Extensometers have also been attached to the four corners of various columns and to portal beams, which read to 1/10,000 of an inch on a gage length of about 50 in. It is hoped that this will make possible the reading of bending and overturning stresses in the columns and of bending stresses in the portal girders. Readings will be taken simultaneously by means of cameras actuated by electricity. In addition, the horizontal deflection of the top of the building during heavy winds will be measured. It will be of great assistance to the engineering profession if these experiments show definite results.

These stress-recording instruments were placed in the 24th story, which is immediately below the base of

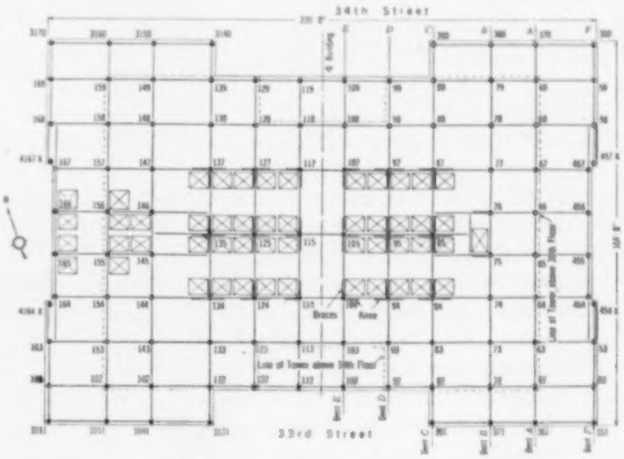


Fig. 6. Wind Bent Plan at 24th Floor

the tower where the main tower columns are accessible on their four sides.

COLUMN SHORTENING MEASURED

All engineers know that steel columns shorten under load, but I know of no case where an actual measure has been taken before. On the Empire State Building, measurements are being made to determine exactly how much lower the various floors are than their theoretical position. These measurements have proceeded to a point where we know that the 85th floor is $6^1/_4$ in. below its theoretical elevation. This agrees very closely with the figured shortening of the columns based on a modulus of elasticity of 29,000,000.

Tests by A. H. Fuller, M. Am. Soc. C.E., of Iowa State College, and Professor Morris, of Ohio State University, would indicate that this modulus of elasticity for structural steel is too high. It may be possible to get a comparison with their results, which were obtained by extensometer measurements, by correcting our results for actual loading and temperature. In a short time information will be available which should give valuable data on this subject.

In reviewing the design for the building, it can be seen that it is noteworthy more for its size than for the varieties and difficulties of its construction. It is seldom that a large engineering problem of building design presents fewer complications and fewer points that are indefinite. The utmost care was taken in its design, and wind stresses were computed by the theory which is generally considered the most reasonable. Thus it may be possible, by future experiments, to clear up some of the indefinite elements of design such as actual wind pressures, the effect of the inertia of the building, the extent and period of sway, and some measure of the effect of walls and partitions on the stiffness of the structure. It is, therefore, greatly to be hoped that this building may be noted, not only for its height and its majestic beauty, but also as a means of promoting engineering knowledge.

Bank of Manhattan Company Building

Foundation and Structural Features of 900-ft. Tower Building at 40 Wall Street

By Henry V. Spurr

Member American Society of Civil Engineers
Chief Engineer, Purdy and Henderson Company, New York

Three office buildings, with tenants still in occupancy, stood on the site of the present 40 Wall Street on May 1, 1929. Record-breaking speed and perfect coordination on the part of the individuals and organizations concerned enabled some of these same tenants to conduct their business in the new 70-story banking structure just one year later. Such haste required the sinking of temporary foundations to hold 25 stories of structural steel before the completion of demolition. Thus, for a time, the wreckers worked over the heads of the foundation crews. Later the tables were turned and erection proceeded over the heads of the wreckers.

In designing the structure, the most modern theories of wind bracing were applied, although a problem of considerable difficulty was presented by the architectural treatment, to which the wind bracing system had to be adapted. How the various problems of design and construction were solved so as to meet the owners' demand for speed was described by Mr. Spurr on January 22, 1931, before the Structural Division at the Annual Meeting of the Society in New York. His paper is here abstracted for the benefit of interested readers.

As PLANNED in the spring of 1929, the Bank of Manhattan Company Building, at 40 Wall Street, was to occupy an irregular plot of approximately 32,000 sq. ft., but the immediate building operations were confined to an area extending north from Wall to Pine Street, which was bounded on the east by the Bank of America and on the west by the United States Assay Office. This area is roughly 150 ft. east and west by

Fig. 1. Plan of the Property Occupied
Setbacks and Tower Indicated

200 ft. north and south, and on May 1, 1929, was covered by substantial buildings of brick and stone, as shown by the photograph. One year later the 900-ft. tower was completed and elevators were transporting tenants to offices high above the street.

Another photograph shows the progress of the work on October 10, 1929, only about seven months after the design drawings were started, and about five and a half months after the beginning of demolition. This gives graphically the result of an unprecedented building program which presented unusual problems in organization and engineering, and in which the whole schedule depended upon the time involved in taking the foundations to rock and in the erection of 70 stories of structural steel.

36–40 Wall Street, New York
Before Wrecking, May 1, 1929

In Fig. 1 is shown a plan of the site with the location of the tower, which is approximately 90 ft. square from the 35th to the 56th floors. The location of the main Banking Room in the second story and of the various setbacks is also indicated. Future extensions to the west are shown by dotted lines.

STRUCTURAL PLANS STARTED

By the middle of March 1929, arrangements had been made to proceed, although the architectural and construction plans were not yet in existence. Surveys were under way, however, and the general size and shape of the building had been determined under the Zoning Law. Preliminary conferences were held, and on March 18, 1929, the consulting architect handed over to the structural engineers a typical floor plan showing the general arrangement of the service openings and the approximate column centers. With this information and the diagrams of setbacks, the architects and engineers started together on the working plans.

It was essential that the bulk of the structural design should be out as soon as possible for ordering the material

and for fabricating the steel; that the foundations should be ready for steel about June 15; and that the steel erection should continue at top speed without interruption. Such a time schedule was a severe taskmaster for all concerned and controlled many features of the design.

In the first place, it would have been very difficult to clear the site and construct the permanent foundations in the time available even if it had been possible to move out all tenants at once and to issue completed foundation design drawings for construction purposes. It was therefore decided to build temporary foundations for the new structure beneath the existing buildings, sufficient to support about 25 floors of steel framing and cinder arches. These temporary foundations were to be subsequently enlarged, as the steel erection progressed, to their final size as demanded by the loads of the finished structure.

October 10, 1929 January 29, 1930
Manhattan Bank Building

It was finally decided that all the main tower columns should rest on concrete piers carried to bedrock, and that the columns outside the tower area could rest either on concrete piers or on steel tubes to rock or hardpan, as circumstances should warrant.

In the meantime, the column loads were being carefully determined so as to secure every benefit to be gained from an exact knowledge of the loads to be carried by the foundations. Unusual working conditions in the field influenced in detail the design of the foundations, and of the billets and grillages, for it was necessary to take advantage of every resource and opportunity to save time. The work was carried forward night and day with great determination while the wrecking went on over the heads of the foundation crews.

Construction Problems to Be Met

This program, simple in principle, was complicated in detail by: (1) the presence of the massive footings and foundation walls of the existing buildings, which were scattered all over the site in inconvenient locations; (2) the necessity of reaching rock 50 ft. or more below the street and 30 ft. or more below water level, in a limited time, which prohibited the use of air; (3) uncertainties as to the time required to execute the work by various methods, complicated by cramped working conditions; (4) variation in the details of the design demanded by the great differences in column loads in the new structure, some footings of which carry the columns of the high tower while others support only 20 stories or less.

To insure sound design and feasible and rapid construction, many schemes were considered and outlined in design for consultations with the foundation contractors and the consulting engineers.

Foundation Plans Executed

The foundation plan, as executed, is shown by Fig. 2. The permanent piers for the tower columns are square or rectangular and the temporary piers, which are shaded in the diagram, were round. Steel cylinders for these temporary piers were driven or jacked into hardpan and the excavation carried to rock. Large steel billets were designed to extend beyond these temporary round piers, and to spread the load to the permanent piers subsequently constructed by excavating around the temporary piers within steel sheet piling driven to refusal.

As excavation proceeded, the temporary piers were braced to the sides of the pit by sections of steel beams welded in position. The permanent piers were concreted to within a few inches of the bottom of the billet and allowed to set, after which the space between the bottom of the billet and the top of the pier was drypacked with a sand mortar, using a quick-setting cement.

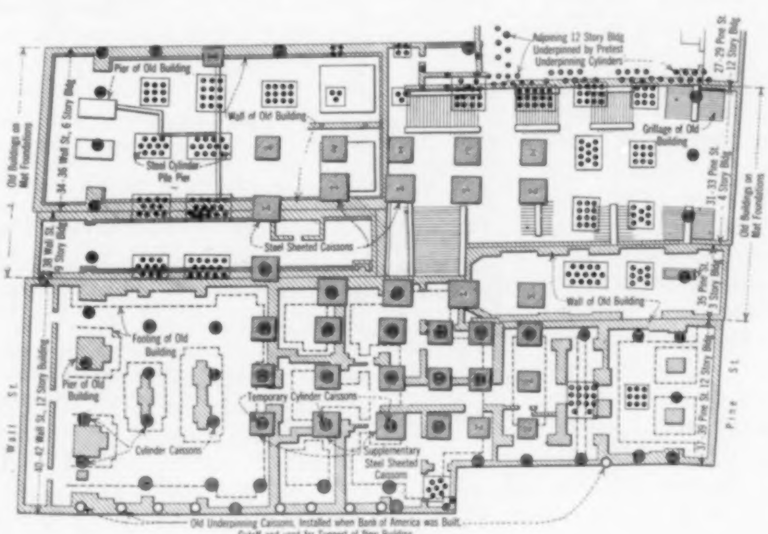
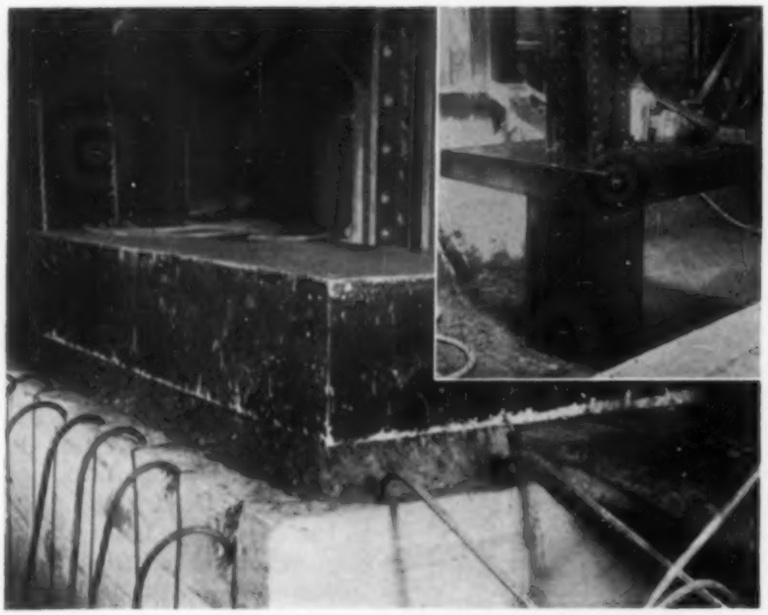


Fig. 2 Foundation Plan for the Building

In the north and south section through the site looking west, Fig. 3, all the various types of foundation construction are indicated. One of the accompanying photo-



PERMANENT TOWER PIER COMPLETED AROUND A CYLINDER
Insert Shows Temporary Tower Pier to Support 20 Tons

graphs, of a billet in place on a temporary pier, taken July 11, 1929, shows how the foundation work went forward as the steel went up. In another photograph may be seen a permanent pier and the dry packing under the billet. This method of erection proved very successful in meeting the time schedule demanded.

Generally, the grillage was arranged to provide opportunity for driving additional tubes after the steel erection was under way, these tubes to be capped and grillage beams added as required to distribute the load to the tubes.

ERECTION OVER HEADS OF WRECKERS

In this manner the foundation work went forward according to schedule and, when the wrecking crews reached the street level, the setting of billets and grillages began. Steel columns were erected before the old foundation walls were removed so that erection proceeded over the heads of the wreckers.

Foundation work previously described included: 69 open caisson piers to hard rock; 27 footings using groups of steel tubes; and the necessary underpinning of adjacent structures on the west. The foundations were ready for the steel two days after the completion of demolition, and the general excavation and supplementary foundation work was finished on July 31, 1929, during erection of the steel work for the lower stories.

Demolition of the buildings on the westerly part of the site started May 1, 1929; demolition of the 12-story Bank of Manhattan Company Building, together with the new foundation work below it, started May 16. The foundations were ready and steel erection began on June 17. During these weeks, plans for the structural steel were developed at top speed to meet the program of erection; the column loads were completed and double checked, and column schedules started for all columns up to the fifth floor. The grillage plan was also completed and revised to meet special conditions in the field. It was released so that material could be ordered and fabrication begun May 8.

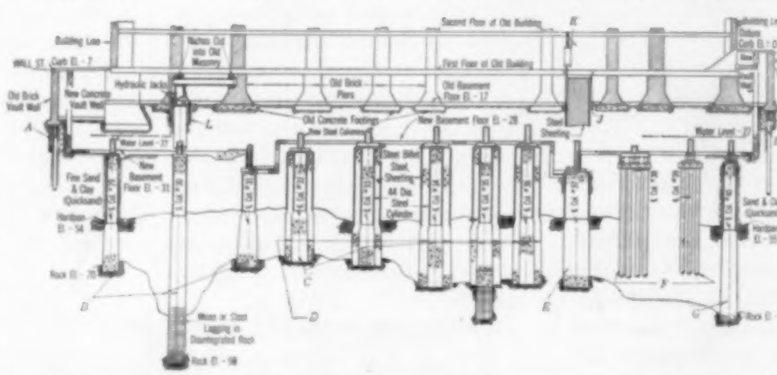
A RACE AGAINST TIME

While the urgently needed architectural information was being obtained, the framing plans were being put together and developed with the wind bracing diagrams. It was necessary to develop an outline analysis of the entire structure, and at the same time to complete dimensioned plans for the lower floors. Any delay in the ordering of material and the fabrication of the steel up to the fifth floor, which included the main trusses over the Banking Room, would have been fatal to the progress schedule.

Throughout the progress of the structural design, it was a race against time to release additional tiers of structural steel for fabrication as fast as shop drawings for the floors below poured in for approval. It was therefore doubly essential that important factors receive thorough consideration and review at the earliest possible moment, and for this reason the wind bracing studies were started with the first framing plans.

DESIGNING THE WIND BRACING

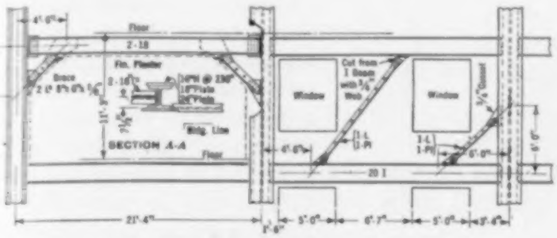
The general intent of the wind bracing design was to secure, in the web system, a rigidity equivalent to a lateral movement of 0.001 of the height of the building, with an average wind pressure of 15 lb. per sq. ft. taken



(A) Pretest underpinning cylinders jacked down under old brick vault walls; (B) cylinder caissons; cylinders jacked to hardpan, shaft excavated through hardpan to rock; (C) temporary cylinder caissons—cylinders jacked down to hardpan, and excavation carried through hardpan to rock; (D) supplementary caissons—steel sheeting driven around cylinders to hardpan, after erection of steelwork; excavation carried through hardpan to rock; (E) steel sheeted caisson—steel sheeting driven to hardpan and excavation carried through hardpan to rock; (F) cylinder caisson—cylinder jacked down to hardpan, and excavation carried through hardpan to rock; (G) tuba steel foundations—16-in. cylinders driven to rock; (H) pretest underpinning—cylinders jacked down under old brick vault walls; (J) old floors demolished to allow driving of steel sheeting for caissons, which were clear of existing walls and piers; (K) hammer suspended from second floor steel of old building for driving of steel sheeting; (L) wood sheeted pit to provide head room for jacking cylinder.

FIG. 3. TYPES OF FOUNDATIONS USED

in the structural frame. The web system is fairly well proportioned to produce this result, and the elastic behavior of the structure to date indicates that this has been approximated.



WEST TOWER WALL LINE (BELOW 35TH FLOOR)

Fig. 4. Knee Bracing in Bent P
Adapted to the Architectural Treatment

The system of bracing was extensively diagrammed and illustrated by details in the early stages of the structural design. This was necessary for prompt approval by the Building Department, and for the proper carrying out of the ideas of the designing engineers without delay.

The most important arrangements of the bracing are perhaps of interest in showing how architectural conditions influenced the design, which was carried out to meet the limitations imposed. In the first place, it was necessary to allocate the wind load to the various lines of bracing before architectural elevations for window openings and pier lines were available. When this information was received it was discovered, as had been feared, that the architectural treatment of the exterior walls, which was, of course, symmetrical, produced a very irregular and awkward arrangement of openings in reference to column centers, as the latter were unsymmetrical to the axis of the tower (Fig. 4).

This condition was complicated by the typical spandrel sections, which called for a spandrel with only 9 in. of masonry between pier lines and with a high window head. Thus the location of the spandrel beam was restricted within very narrow limits, as indicated in Fig. 5. It was very important architecturally to use only a single line of wall steel, and this single beam was limited in depth to 20 in. and in flange width to $7^1/_4$ in. so that a definite limit was placed on the strength and rigidity of all wind bracing beams in the exterior walls.

The solution was an irregular system of knee braces and diagonals to reduce the moments in the beams and columns so as to secure the desired rigidity and reduce the field riveting to a minimum. Wind bracing members were designed for stresses under wind alone, controlled by the rigidity desired. In general, these stresses were less than those allowed on the basis of strength. As is customary in a wind analysis, rivet stresses were increased.

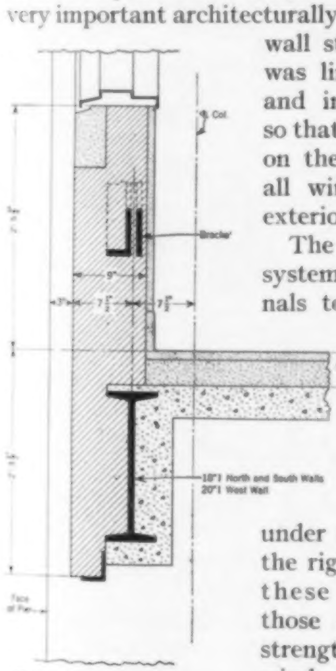


Fig. 5. Spandrel Section in Tower

The top and bottom connection noted by the letter T in Fig. 10 are cut from a 24-in. 120-lb. standards I-beam, riveted through the beam flanges and the column face.

ARCHITECTURAL FEATURES PRESENTED DIFFICULTIES

It is evident, from this general description of the wind-bracing system, that architectural conditions were not ideal for a nicely balanced academic design. Had the normal amount of time been available, however, to thoroughly consider all phases of the wind bracing system with the architects, it could have been very nicely developed. It is doubtful, however, with the main arrangement of columns and service areas unchanged, whether the practical effectiveness of the system would be materially improved, except by generally increasing the provisions for wind resistance.

It was considered very important to secure proper rigidity in a tower 900 ft. high and approximately 90 ft. square above the 35th floor. The problem was complicated by the irregular and unsymmetrical column spacing in both directions, by the location of the service areas along the east side of the tower, and that of the columns in reference to the elevator shafts and corridors. Bent P is shown in Fig. 6.

In the eastern half of the tower, columns were closely spaced with considerable opportunity for effective bracing in a north and south direction. It was, however, essential to secure symmetrical wind resistance, which could be best effected by a full development of the four-column bent in the west wall of the tower. This bent is very important in a north and south direction, and is supplemented by the bents in the open office space running north and south, where shallow split beam connections were adopted to suit the architectural conditions. The framing plan for tower floors 41 to 56 is shown in Fig. 7.

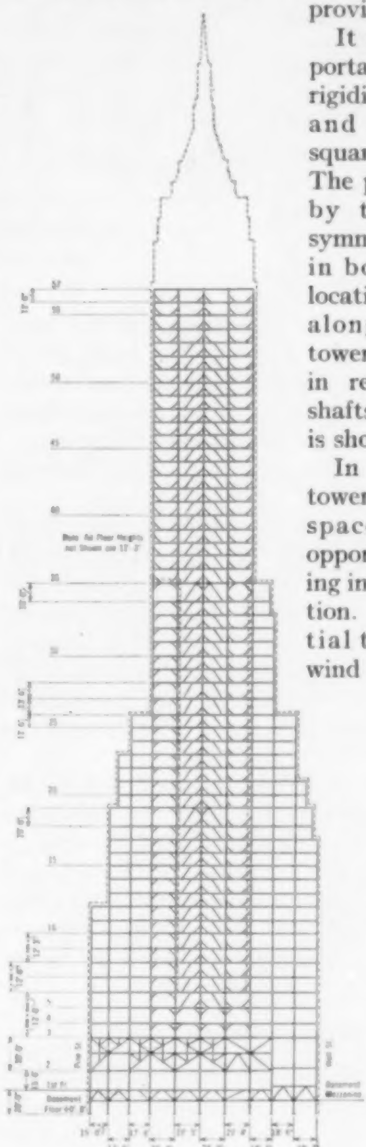


Fig. 6. Wind Bent P

EAST AND WEST BRACING

In an east and west direction, great reliance was placed on the bents in the north and south walls of the tower, but considerable rigidity was secured in this direction also by introducing deep braces where possible in the

service areas, supplemented by deep connections into the webs of the columns in the open office area. These web connections are partly hidden in the column flanges and fireproofing and are hardly noticeable in the finished structure. They are very effective in reducing the moments in the columns in their weak direction and in stiffening the connecting double 18-in. channel members. The same field rivets through the column web serve for two connections. These members extend the elastic base of the effective bracing in interior column lines in an east and west direction, and tend to develop the full stability of the structure.

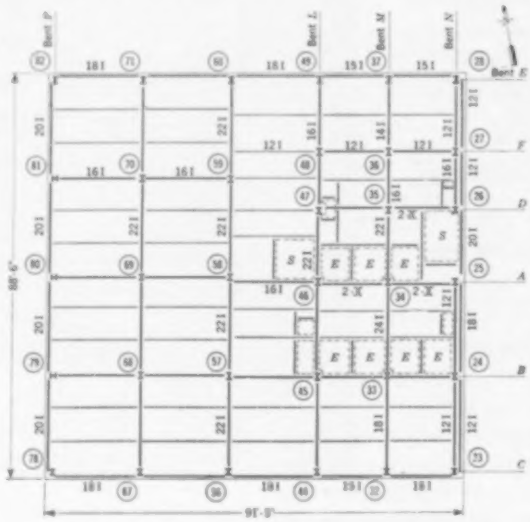


FIG. 7. FRAMING PLAN FOR TOWER FLOORS 41st to 56th Floors

The wall bents in the north and south walls of the tower become interior column lines below the 29th and the 35th floors, respectively, and the bracing was modified accordingly. The north and south bent in the west wall of the tower extends with very little modification in type of bracing down to the fifth floor, where it is hidden in the west wall of the Banking Room. Eight of the main tower columns are picked up at the fifth floor on four trusses running east and west, and these trusses are carried on free standing columns through the Banking Room story. This makes the bracing in the west wall of the Banking Room very important.

Similarly, the north and south line of bracing along the west side of the service area is very important. Its location tends to reduce the wind load on the bent in the west wall of the tower, and effective bracing was readily concealed in the permanent partitions. This bracing, Bent L, extends along the east side of the Banking Room to the foundations, and is supplemented by two parallel lines of bracing in a north and south direction in the eastern half of the tower.

The first bent to the east of Bent L is called Bent M, and the bracing is concealed between the elevators. Bent N, located in the line of the east wall of the tower, is not so important, due to the proximity of Bents L and M, but is necessary to produce a balanced system in a north and south direction. In these various lines of bracing, deep knees and diagonals are used as far as possible, connected by rivets in double shear.

BRACING SOMEWHAT IRREGULAR

Below the third floor, which is the level of the bottom chords of the large trusses over the Banking Room, reliance in an east and west direction is placed largely in deep bracing in the service areas on the east side of the banking space in the first and second stories. This bracing accommodates itself to architectural conditions and is somewhat irregular in arrangement.

In the north and south walls of the tower, where the knee braces are above the floor line, the bracing is in the exterior walls, with a single I-beam used to take wall, floor, and wind loads. At the base of the tower, where these bents become interior lines of bracing, double channel bracing members are used, which frame into the webs of the columns with deep connections.

The important bent in the west wall of the tower is in the exterior masonry for 50 stories except between Columns 81 and 82, while, in the lower stories, it is inside the building and the braces are below the floor line. In the exterior walls a single 20-in. standard I-beam is used to take floor, wall, and wind loads. The bracing was arranged to suit the architectural conditions without any modification to meet structural requirements. The knee braces and diagonals are made up of one angle and one plate separated by washers to provide for connections using rivets in double shear. All members are designed to take compression as well as tension.

SPECIAL BRACING USED

Special bracing was employed in the two panels of Bent N in the east wall of the tower. There the proximity of the Bents L and M reduces the wind load on this exterior wall line. The face of the east wall is 2 ft. 0 in. beyond the column center line, so that the bracing is beyond the column face, producing, with the wall, an eccentric condition of loading on the columns but no direct bending from wind. Bracing below the 35th floor is on the center line of the columns.

Above the 34th floor, the special bracing is concealed in the permanent partitions and, together with the bracing in the east wall, takes the wind load in a north and south direction for the eastern half of the tower. Two interior lines of bracing in a north and south direction

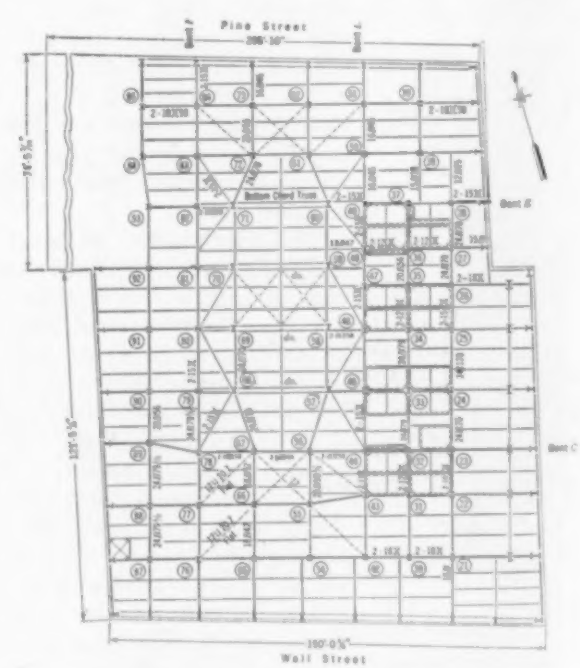


FIG. 8. PORTION OF THE THIRD FLOOR FRAMING PLAN

are obtained between Columns 56 to 60 and 67 to 71 by the use of 22-in. I-beams with split beam connections on each end. These interior lines, with the bracing in the west wall of the tower, balance the bracing in Bents L, M, and N.

BENTS STRONGER IN LOWER STORIES

Below the 36th floor, Bents A, B, and D have increased strength and stiffness. In general, the bracing is heavier and the bents have a greater depth in the lower stories, as the building extends beyond the tower both east and west.

Wind bracing members in the lower stories are generally two 18-in. channels on column centers with deep connections at each end. Additional strength and stiffness is secured by the framing on the column lines to the north as the building extends below the setbacks on Pine Street.

In the four lines of bracing in a north and south direction in the lower part of the building, Bents P and L in the west and east walls of the Banking Room, respectively, are the most important. These two similar lines of bracing, one of which is shown in Fig. 10, pick up the wind load brought down the two lines of columns, which are supported on trusses at the fifth floor. Heavy portal bracing at the fourth and fifth floors between the end posts of these trusses transfers the wind load, through horizontal bracing in the third floor, to Bents L and P. It is to be noted that all these bents are wider in the lower stories than in the tower above, and the bracing is extended to the foundations.

In determining the horizontal wind shears and the axial column loads, a pressure of 30 lb. was used above the 60th floor, and 20 lb. per sq. ft. from the eighth floor to the 60th floor. Thus the strength of the design was inclined upward. The rigidity of the design, computed on the basis of these loads, was also inclined upward by maintaining typical knee braces in the upper stories of the tower, as demanded by shears at lower levels. This had the effect of discounting the drop in wind load from 30 lb. to 20 lb. at the 60th floor without producing excessive shears in the lower stories.

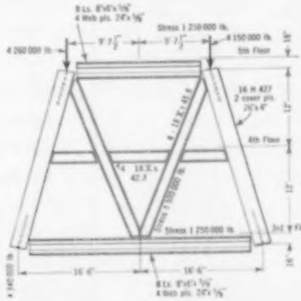


FIG. 9. DETAIL OF A BANKING ROOM TRUSS

In the lower stories of Bent P, the northern panel is an interior line of bracing, and the knee braces are below the floor in the open office space. This also illustrates the way in which the structural details had to be adapted to the architectural treatment.

A portion of the third floor framing plan of the building, which covers the entire area of the first operation at this level, is illustrated in Fig. 8. This diagram shows the arrangement of horizontal bracing to transfer wind loads in a north and south direction to Bents L and P, on either side of the main Banking Room. Also indicated is the horizontal bracing, which was introduced to develop additional lines north and south of the tower in an east and west direction. These additional lines

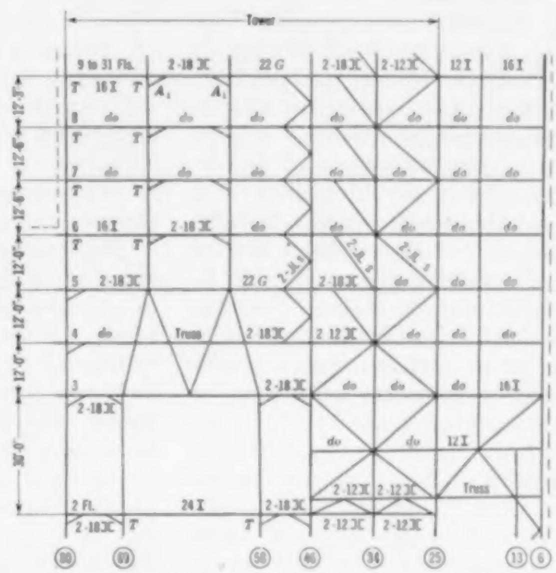


FIG. 10. BENT L IN THE WALLS OF THE BANKING ROOM

of bracing occur where the 18-in. channel members are indicated in the plan.

The four heavy trusses spanning the Banking Room, and extending from the third to the fifth floors, support the heavy column concentrations of the 60 floors above, and are noteworthy for simplicity of design. Details of one of these trusses are shown in Fig. 9. In principle, the eight tower columns have a double bend at mitered joints, which were accurately milled to give perfect bearing. The chords and web members hold the bent columns in position.

DESIGNING THE PYRAMIDAL TOP

The extreme top of the building was very carefully studied, and the design was based on the local effect of a wind pressure of 40 lb. per sq. ft. in the upper 100 ft. The sloping rafters forming the pyramidal top were made to serve as continuous ties from top to bottom by straps at all points of framing to levels of horizontal steel, thereby supplementing the rigidity secured by the levels of horizontal framing within the pyramid.

The structural design drawings of the whole building, which were started on March 18, 1929, were filed in the Building Department on the first of the following May. By May 24, 1929, they had been released for the ordering of material up to the 56th floor.

The building was designed by H. Craig Severance, Inc., architect, and Yasuo Matsui, associate architect. The builder was Starrett Brothers, Inc.; Purdy and Henderson Company were consulting engineers on the superstructure; Moran and Proctor were consulting engineers on the foundations; and the underpinning and foundation work was done by Spencer, White, and Prentis, Inc. The contract for the structural steel was given to Levering and Garrigues Company.

Wind Bracing in Tall Steel Buildings

Structural Division's Sub-Committee Makes Progress Report

THIS report brings forcibly to the attention of engineers the great lack of actual data on the relation between building behavior during winds and the actual distribution of wind forces producing the deflection. It is noteworthy that devices for measurement of wind forces, building movements, and the resultant stresses in structural members have been recently installed in a few high buildings for the purpose of studying skyscraper behavior. Wide interest has already been manifested in the progress report of the Structural Division's Sub-Committee, appointed to investigate this hitherto neglected field. For the benefit of the membership it is published here as it was presented before the Division on January 22, 1931, at the Annual Meeting of the Society in New York.

ALTHOUGH the Sub-Committee on Wind Bracing in Steel Buildings has been operative for an insufficient time to make possible the issuance of a report covering all important aspects of the subject, the intensification of the wind-bracing problem brought about by the recent trend toward the erection of buildings of 1,000 ft. in height, or more, makes it desirable that there should be pointed out at this time certain considerations which the members believe to be extremely important.

These have to do, for the most part, with matters of stiffness rather than strength. What is here submitted is, therefore, not to be taken as a comprehensive or final report, but merely as an expression of views on some of the newer and more important phases of the bracing situation brought about by recent constructional developments. It is hoped to deal with other phases in later reports, but in this, the first progress report, attention will be directed wholly to four topics, namely: (1) magnitude and character of the wind force; (2) rôle of the non-skeleton parts of the building in resisting wind force; (3) allocation of wind force to braced bents; and (4) minimizing of deflection.

MAGNITUDE AND CHARACTER OF WIND FORCE

Whether the resistance of a building to wind be provided by one structural element, or by several in combination, there should be a certain stipulated wind force to be met, and to be met in such a manner as to safeguard the occupants against either injury or discomfort. Any prescription of this wind force must, obviously, be made with due regard to the maximum wind velocities, and the forces resulting therefrom, that have been observed in the country.

In Table I there are listed 27 cases of average recorded wind velocities, V_r, in continental United States, amounting to 90 miles per hour or more, over the standard 5-min. period. These occurrences were widespread and not confined to one section of the country. The observations were taken with Robinson 4-cup anemometers, except in the case of that at Miami Beach, Fla., in 1926, which was taken with an instrument of the 3-cup type. When the correction factors of the U.S. Weather Bureau are applied to these, the true maximum average velocities, V_t, listed in Col. 4 of Table I, result.

GUST VELOCITIES STUDIED

For design purposes, however, consideration must be given, not so much to these corrected average velocities, as to the maximum gust velocities, V_g, that arise during these 5-min. periods. In certain of the listed cases, some indication of the additional gust effect has been afforded by observations taken over a shorter period than 5 min., for example, over 1 or 2 min., as indicated in Col. 5 of the table. Inspection of these shows that, although the mean velocity is over 90 miles per hour, and in some cases very much more, there is an additional gust increment of from 18 to 48 per cent, with an average of 27 per cent. G. C. Simpson found, in studying typical anemograms, that the extreme gust velocity

TABLE I. CHARACTERISTICS OF 27 WINDS IN CONTINENTAL UNITED STATES HAVING A RECORDED VELOCITY, V_r, OF 90 MILES PER HOUR OR OVER

These velocities were taken over 5-min. periods, and the standard correction factors of the U.S. Weather Bureau have been applied.

Place	Date	Maximum Average Recorded Velocity, V_r, Miles per Hour	True Maximum Average Velocity, V_t, Miles per Hour	Probable True Maximum Gust Velocity V_g, Miles per Hour	Force Due to Maximum Gust Velocity, $P = 0.0033\ V_g^2$ lb. per sq. ft.
(1)	(2)	(3)	(4)	(5)	(6)
Amherst, Mass.	1895	93	71	89 (1.25 V_t)	26
Block Island, R. I.	1898	90	69	86 (1.25 V_t)	24
Buffalo, N. Y.	1920	96	74	92 (1.25 V_t)	28
Burrwood, La.	1915	124	94	117 (1.25 V_t)	45
Cape Henry, Va.	1899	105	80	100 (1.25 V_t)	33
Cape Lookout, N. C.	1879	100	77	96 (1.25 V_t)	30
Charleston, S. C.	1893	96	74	92 (1.25 V_t)	28
Corpus Christi, Tex.	1916	90	69	86 (1.25 V_t)	24
Galveston, Tex.	1900	93	71	89 (1.25 V_t)	26
Hatteras, N. C.	1899	105	80	125 (Estimated)	52
Kitty Hawk, N. C.	1879	100	77	96 (1.25 V_t)	30
Manteo, N. C.	1879	105	80	100 (1.25 V_t)	33
Miami Beach, Fla.	1926	128	122	132 (2 min.)	58
Mobile, Ala.	1916	115	88	110 (1.25 V_t)	40
Mt. Washington, N. H.	1876	186	140	175 (1.25 V_t)	102
Mt. Washington, N. H.	1883	152	115	144 (1.25 V_t)	68
Mt. Washington, N. H.	1886	111	85	105 (1.25 V_t)	37
New York, N. Y.	1912	96	74	91 (1 min.)	27
New York, N. Y.	1914	90	69	86 (1.25 V_t)	24
New York, N. Y.	1915	90	69	86 (1.25 V_t)	24
North Head, Wash.	1921	126	96	114 (1 min.)	43
North Platte, Neb.	1878	96	74	92 (1.25 V_t)	28
Pensacola, Fla.	1916	114	87	91 (Estimated)	27
Pensacola, Fla.	1917	97	74	92 (1.25 V_t)	28
St. Paul, Minn.	1904	102	78	98 (1.25 V_t)	32
Tatoosh Island, Wash.	1921	110	84	105 (1.25 V_t)	36
Topeka, Kans.	1890	96	74	92 (1.25 V_t)	28

might be 30 per cent in excess of the mean hourly velocity.[1]

Observations at Washington, with a recording pressure tube anemometer, showed gust velocities of from 17 to 50 per cent in excess of the 1-mile maximum corrected velocity.[2] Dryden and Hill observed that for winds of less than 40 miles per hour and at heights of less than 150 ft., the maximum gust velocities are about 50 per cent greater than the mean over 5 min.[3] C. F. Marvin, Chief of the U.S. Weather Bureau, states that an analysis of the storm velocities observed during a period of 15 years at Baltimore shows an average maximum 1-mile velocity 19 per cent in excess of the average maximum 5-min. velocity.

The 1928 record of daily wind velocities at Chicago showed that the average daily gust velocity, as determined by a Dines pressure gage, exceeded the average daily maximum 5-min. velocity by 35 per cent. At the same time, the average monthly gust velocity, similarly determined, exceeded the average monthly maximum velocity by 55 per cent. Twenty selected cases gave an excess of 74 per cent. One case of extreme variation gave 110 per cent excess.[4]

Where specific evidence is lacking, it has been deemed reasonable to add 25 per cent to the true maximum average velocity, V_t, in order to obtain the probable true maximum gust velocity, V_g. While, in general, the ration of the gust increment to the mean velocity decreases with height, and probably disappears at the level at which the gradient wind is first attained, yet for some considerable distance above an irregular, disturbing earth surface, such as is afforded by the profile of a modern city, the gust effect with respect to the 5-min. mean may well amount to the percentage assumed.

The maximum gust velocities of Col. 5, Table I, have been plotted on Fig. 1 at the anemometer heights, which have been kindly supplied by the Chief of the U.S. Weather Bureau.

In Col. 6 of the table, the force of a gust on a plane square foot normal to the wind direction has been listed, employing the usual type of formula, with the Eiffel coefficient, that is,

$$P = 0.0033\,V_g^{\,2}.$$

In this, both pressure and suction effects have been included. The coefficient is lower than is sometimes employed, but it rests on the basis of very careful experimentation.

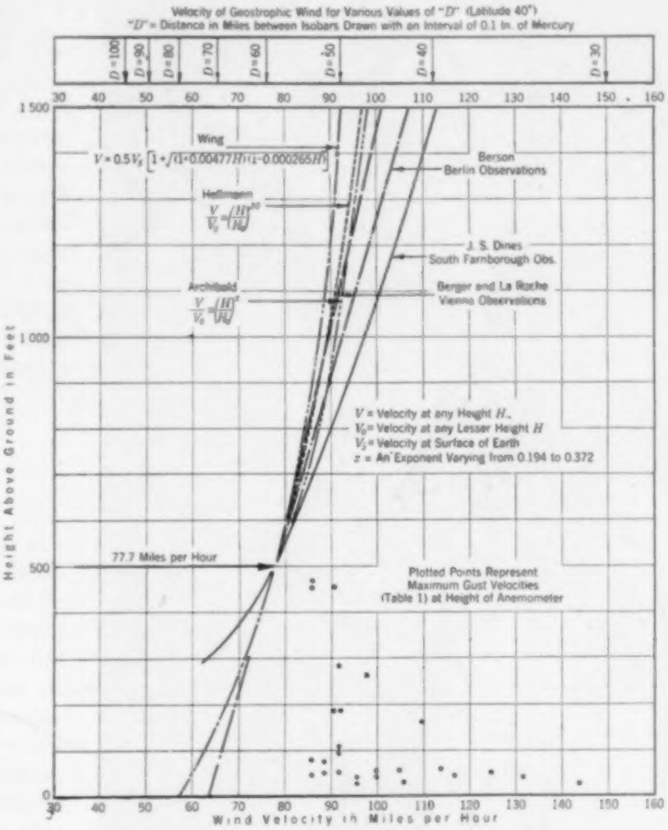


FIG. 1. VARIATION OF WIND VELOCITY WITH HEIGHT

CALCULATING THE WIND FORCE

Examination of the table reveals wind forces ranging from 24 to 102 lb. per sq. ft. The latter value, representing a very early observation at Mount Washington, 5,506 ft. above sea level, has been discarded in the consideration that follows, on the ground that its great excess over all the other maximum values makes it questionable and probably inapplicable to conditions likely to exist in the neighborhood of towns and cities. These calculated pressures, it should be remarked, are such as presumably would have been experienced under such relatively good exposures as exist at anemometer stations, and at the height of the instrument itself.

The observations recorded in Table I were made, for the most part, with instruments at no great height above the ground. In no case did the height exceed 454 ft., and in nearly every instance it was very much less. This being the case, there arises at once the question as to how much greater the velocities, and the forces pertaining to them, would have been at 500, 1,000, or 1,500 ft. above the ground.

VELOCITY INCREASED WITH HEIGHT

Experimentation has shown that, in general, the velocity of the wind increases with height up to the level at which the gradient wind, that is, the wind freed of surface disturbances, is reached. Cases have been observed in which the velocity increased for a moderate distance above the ground and then fell away to a lesser figure, but a gradual, if irregular, increase is the more characteristic.

Many efforts have been made to derive a generally applicable law of increase of velocity with height, but it is now generally admitted that such is impossible, so great are the effects of ground conditions and turbulence. Nevertheless, it is helpful to consider certain well authenticated cases of fairly regular increases of velocity with height. If such increase has occurred in numbers of recorded cases, it may well occur again, and the designer should not be unprepared for it.

In Fig. 1, there have been plotted, running through a point representing a velocity of 77.7 miles per hour (P = 20 lb. per sq. ft.), at a height of 500 ft., a series of observational curves extending up to the 1,500-ft. level and indicating the manner in which velocity increases

Nesmith

CHRYSLER BUILDING, NEW YORK
Chanin Tower on the Left, 500 Fifth Avenue Between

with height from the 500-ft. level upward. While these curves were derived on the basis of velocities at 500 ft. considerably less than 77.7 miles per hour, nevertheless it is of interest to note the increments to the latter velocity with height that would arise if the rate of increase demonstrated for lower basic velocities were to hold for higher ones. The possibility of this is indicated in the fact that J. S. Dines found, in connection with his observations at South Farnborough and Pyrton Hill, England, that increase of velocity with height was more rapid for winds having a velocity of over 22 miles per hour at the 1,640-ft. level than for winds having a lesser velocity at this level.[5]

In two cases the curves plotted in Fig. 1 were based on observations taken at lesser heights than 1,500 ft., but in the other four the observations extended above that level. S. P. Wing developed his formula

$$V = 0.5V_s\left[1 + \sqrt{(1+0.00477H)(1-0.000265H)}\right]$$

from observations taken with anemometers at the 15- to 90-ft., 300-ft., and 492-ft. levels at the Ballybunion wireless station, Ireland.[6] In this formula, V = velocity of wind in miles per hour at a height, H, in feet above the ground, and V_s = velocity in miles per hour at the surface of the ground.

E. D. Archibald's formula,

$$\frac{V}{V_o} = \left(\frac{H}{H_o}\right)^x,$$

was based on observations with anemometers suspended from kite wires.[7] The upper instrument attained a height as great as 1,300 ft., but its mean height was 1,095 ft. In the formula, V = velocity at any height H, V_o = velocity at any lesser height H_o, and x = an exponent varying from 0.372, for the lowest zone, to 0.194 for the highest zone studied.

Hellmann's work with anemometers at the Nauen wireless station extended up to 846 ft. He proposed the relation,

$$\frac{V}{V_o} = \left(\frac{H}{H_o}\right)^{0.20},$$

in which the symbols have the same meaning attached to them as in connection with the Archibald formula.[8]

The work of J. S. Dines at South Farnborough and Pyrton Hill, to which reference has already been made, makes possible the plotting of the relation of velocity to height up to 1,640 ft. This has been done for winds of 22 miles per hour and over, in Fig. 1.

Berson's analysis of observations made with pilot balloons at Berlin up to heights of 6 km. give the basis of another curve.[9]

A somewhat similar curve, based on an analysis by Berger and LaRoche of the results of pilot balloon observations at Vienna in 1911–1914, is also shown in Fig. 1.[10]

Another series of observations carried on over several years at Drexel, Neb., but not plotted in Fig. 1, gives a curve closely approximating to that of Hellmann.[11]

USE OF GRADIENT WIND VELOCITIES

There is another basis upon which the velocity of the wind at elevations corresponding to the tops of very tall buildings may be estimated. At a height of 1,500 ft. above a fairly regular earth surface, the wind velocity will approximate that of the gradient wind. C. F. Marvin states, with reference to the high winds listed in Table I, that the gradient wind might be assumed as having occurred at a height of 1,200 to 1,500 ft., and would have had a velocity roughly double that of the true observed velocity, V_t.[12] Over an irregular surface, the height at which the gradient wind is first met will be greater. Along the top of Fig. 1 there have been indicated, for latitude 40°, the velocities of the geostrophic wind, that is, the gradient wind for straight isobars, corresponding to distances, D, of from 30 to 100 miles between isobars drawn with an interval of 0.10 in. of mercury. Thus, where $D = 40$ miles, a case that is by no means unattainable, the geostrophic wind velocity amounts to 112 miles per hour. Thus a very helpful check on the general trend of the velocity variation curves plotted in Fig. 1 is available.

In Fig. 2 the wind forces listed in Col. 6 of Table I, with the exception of the results of the 1876 observation at Mount Washington, have been plotted at the correct anemometer heights.

It is, of course, unreasonable to consider the lower portions of tall buildings, shielded as they are, to be subjected to wind forces such as these. A building exposure at a height of, say, 200 ft. in a city is very much less perfect than the exposure of an anemometer, which is designedly made as good as possible. Consequently, the Sub-Committee would recommend that for the first 500 ft. of height the prescribed wind force be 20 lb. per sq. ft. From the 500-ft. level up it is recommended that it be increased by 2 lb. per sq. ft. for each 100 ft. of height, thus amounting to 30 lb. per sq. ft. at the 1,000-ft. level and to 40 lb. per sq. ft. at the 1,500-ft. level, as shown in Fig. 2.

Assuming that the wind velocity increases with height above the 500-ft. level, in accordance with the general trend of the curves plotted in Fig. 1, the corresponding wind force per square foot at high elevations is seen to be well represented by the suggested specification. At 1,000 ft., the force indicated conforms to the 30 lb. per sq. ft. long specified by the more conservative building codes of the country for buildings generally. It is the opinion of the Sub-Committee that, until ample experimental justification for so doing arises, the prescribed wind force be not reduced below that here recommended. Any lessening of gust effects with increasing height is amply offset by simultaneous reduction of the shielding and interference due to adjacent structures.

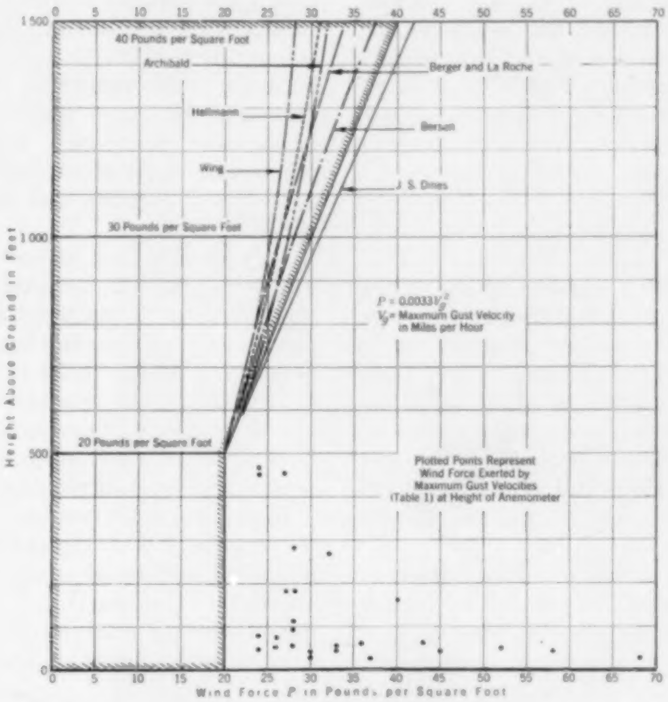


FIG. 2. VARIATION OF WIND PRESSURE WITH HEIGHT
Sub-Committee Recommendation Indicated

It is further recommended that in no member should the stresses due to the combined action of this and all other loads exceed 75 per cent of the elastic limit of the material, nor should the overturning moment due to wind force exceed two-thirds of the moment of stability from dead load only. Proper attention to deflection considerations will, as a matter of course, keep combined stresses well within the limit mentioned.

It has not been deemed necessary to divide the prescribed wind force into pressure and suction action for typical tall buildings. For structures with rounded roofs, such as armories, hangars, and drill sheds, and for mill buildings or buildings with large open interiors and walls in which large openings may occur, this may be necessary.

PART PLAYED BY NON-SKELETON PARTS

If the floors of a building are to serve as effective horizontal girders or diaphragms for the delivery of the windload increments that arise in each story to the braced bents that are provided to receive them, they must possess a certain requisite strength and rigidity under loads in their own planes. Bracing planes may run in more than one direction, and hence such diaphragms may be called upon to deliver load along their lines of minimum strength. If a floor is incapable of serving as a horizontal distribution unit, each bent will obviously be required to take the wind from the two adjacent half bays.

As ordinarily constructed, the walls of a modern tall steel building cannot be relied upon to absorb any appreciable fraction of the applied wind force. Apart from the uncertainty as to whether the walls act integrally with the frame at the outset, it is obvious that under heavy horizontal loading they will crack and cease to be a dependable element of strength. Cracked masonry should no more be counted in estimating safe resistance than cracked concrete on the tension side of a flexural member. Moreover, under modern construction pro-

cedure, the walls in certain stories, particularly the lower ones, are often not begun until many of the other stories have been enclosed. In setback buildings, the walls in the planes of the tower sides are, of course, discontinued below the roof of the widened portion of the building. Nor can wind resistance be counted upon for partitions which, in general, are removable. For these reasons, the Sub-Committee is of the opinion that, whatever may be their rôle in lessening deflection and vibration, walls and partitions in buildings having a high ratio of height to width should be ignored in strength calculations, and provision made in the structural frame for 100 per cent of the recommended wind load.

ALLOCATION OF WIND FORCE TO BRACED BENTS

Granted that the floors are capable of serving as effective distribution diaphragms for the applied wind loads, and that the tops of the columns in a given story deflect equal amounts, the various braced bents passing through the floor can be considered as taking loads only in proportion to their rigidities, or inversely as the deflections that would be produced in them under equal loads. This should be a fundamental principle governing any assumptions made respecting the distribution of wind force among bents.

If the floors meet the requirements already given or, in the event that they do not, if they are adequately supplemented by bracing in horizontal planes, there need be no maximum limit of spacing of braced bents set up, nor any restriction imposed on carrying all the wind force to the end or side walls, if the bracing therein be sufficient to provide for the entire wind force.

MINIMIZING DEFLECTION

Quite apart from the obvious necessity for providing adequate strength in bracing members and details, and for the distribution of wind force among bents in proportion to their relative rigidities, care must be taken to insure that deflections and vibrations are kept within such limits as render tall buildings comfortably habitable. Deflections arise from two sources: (1) deformation of the chords of the virtual truss that may be assumed to exist in each braced bent; and (2) deformation of the web system of this truss. In very high frames, the axial deformation of the columns which act as truss chords may be very serious and should by no means be neglected.

Only experience will reveal the relation between computed maximum deflection and comfortable occupancy. By reason of the present impossibility of appraising in advance the restraining or dampening effect of the nonskeleton parts of a building on deflection, it is convenient to employ, as a measure of the stiffness, the relation between the maximum deflection of the top of a frame and its height under maximum wind load, assuming the frame to carry the entire lateral force. This might, perhaps, be called, for ease of reference, the "deflection index" or "deflection characteristic." Due to inertia and to the dampening effect of walls, partitions, and floors, it does not represent the actual deflection that will arise, but some multiple of that quantity. Nevertheless, it is a convenient standard by which to judge the probable stiffness of a building and its probable freedom from disturbing vibrations.

Making use of this deflection index as a basis of rating or judgment, some guidance may be afforded the designer. Thus, it has been found that tall buildings with a deflection index of 0.002 under assumed triangular loadings somewhat lighter than those shown in Fig. 2, that is, with a maximum deflection computed as above amounting to 0.002 times the height, have a satisfactory behavior in the matter of deflection and vibration. In very high buildings this figure represents, not only a satisfactory occupancy basis, but about the upper practicable limit of attainable stiffness without liberal additions to columns and other main members for wind effect only.

It is possible that higher theoretical frame deflections would be tolerable, but relaxation in this regard should come only as a result of accumulated experience. It may be of assistance in this connection to note that well designed buildings of 20 to 25 stories in height, having deflection indices upward of 0.004 or 0.005, have behaved satisfactorily. In addition to securing comfortable occupancy, a proper limitation of deflection guards against injury to internal and external masonry.

In judging deflection and vibration behavior, it would be very helpful to engineers to have records of actual measured horizontal movements for a wide variety of buildings. It is urged that data of value in dealing with this matter be established by experimental determinations of such quantities for recently erected tall buildings.

Complications of layout attendant on modern architectural considerations render uniformity of type in bracing for different parts of the frame difficult, if not impossible, of attainment. Several different types may be used in one story in the various bays of a braced bent. Since for equal deflections deep bracing is much more economical than shallow bracing, it should be employed wherever it is at all practicable. Hitherto, architectural reasons have been set up as a barrier to deep bracing, but when the relation of the frame to the completed building is more generally appreciated, the task of the engineer in securing rigid and economical construction will be rendered easier.

There is much of value that may be learned through a careful study of the relative rigidities of various types of wind connections. Work now in progress, but upon which the Sub-Committee does not undertake to express an opinion at present, may yield useful information on this matter.

In view of such facts as have come to its attention, and without, at this time, attempting to formulate comprehensive recommendations, the Sub-Committee believes that any existing disposition towards relaxation of the requirements respecting wind force and wind bracing should give way to an earnest effort on the part of all concerned to discover and to observe those structural limits and conditions within which tall buildings may be made, not only safe under the action of wind, but comfortably habitable. The difference between the cost of a well braced and a poorly braced building is so small that there is no justification for ill-advised efforts at economy in this direction. At most, the cost of adequately bracing a tall steel building is a negligible

percentage of the total cost of the building.

RECOMMENDATIONS AND CONCLUSIONS

A summary of the more important recommendations and suggestions advanced above would be:

1. That the prescribed wind force for buildings for the first 500 ft. of height be a pressure of 20 lb. per sq. ft., and that above this level it be increased at the rate of 2 lb. per sq. ft. for each 100 ft. of height.

2. That in no member should the stresses due to the combined action of this and all other loads exceed 75 per cent of the elastic limit of the material, nor should the overturning moment due to wind force exceed two-thirds of the moment of stability due to dead load only.

3. That for structures with rounded roofs, such as armories, hangars, and drill sheds, and for mill buildings or buildings with large open interiors and walls in which large openings may occur, considerationbe given to the possible necessity for dividing the wind force into pressure and suction effects.

4. That, in calculations for strength, the walls and partitions of a tall building be ignored and the structural frame be required to resist 100 per cent of the recommended wind load.

5. That the various braced bents passing through a floor be considered as taking loads only in proportion to their rigidities.

6. That structural frames be so designed as to insure that deflections and vibrations will be kept within such limits as to render buildings comfortably habitable.

7. That engineers having to do with tall buildings undertake to determine experimentally the actual horizontal movements of buildings of various types and proportions, so that means may be devised for predicting the behavior of a building under wind force.

8. That, in the interests of rigidity and economy, deep rather than shallow bracing be employed wherever it is at all practicable.

Nesmith

BANK OF MANHATTAN COMPANY BUILDING
Shielding of Lower Portions of Tall Buildings Is Apparent

Respectfully submitted,

CLYDE T. MORRIS
N. A. RICHARDS
FRANCIS P. WITMER
C. R. YOUNG
Chairman

December 13, 1930

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[2] *Engineering News-Record*, December 9, 1926, p. 948
[3] *Research Paper No. 221*, U.S. Bureau of Standards, p. 655
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[5] Report of Advisory Committee for Aeronautics (Great Britain), 1912–1913, p. 310
[6] *The Electrician*, July 1, 1921, p. 6
[7] *Nature*, April 22, 1886, p. 593
[8] *Sitzungsberichte der königlich preussischen Akademie der Wissenschaften*, 1917, p. 174
[9] Hann and Süring, *Lehrbuch der Meteorologie*, 4 ed., pp. 402–406
[10] *Österreichische Flug-Zeitschrift*, Feb. 1918, p. 44, and Mar. 1918, p. 67
[11] Humphreys' *Physics of the Air*, 2 ed., p. 127
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Improvements in Handling Building Material

Mechanical Devices for Moving Masonry Reduce Breakage

By George G. Wheat
Consulting Engineer, Brooklyn, N.Y.

New York's construction bill is in the neighborhood of a billion dollars annually. This article, prepared from a paper presented by Mr. Wheat on January 22, 1931, before the Construction Division at the Annual Meeting of the Society, indicates the methods that have been and are being developed for handling the thousands of millions of pieces of building materials that are used during a year of modern building construction. These methods, if extended to the movement of materials within the building, will result in increased speed, reduced breakage, and, ultimately, in reduced cost to the owner.

THE subject of moving building materials may seem a prosaic one but, in the field of construction, getting the material to the job is just as essential as is the commissary department of an army. Methods of handling and moving building materials can be improved; construction men are further improving the ordinary methods now in use. Safety of workmen, rush work, and confusion on the job, overtime work and last but not least, heavy damage to materials, can all be eliminated by carefully coordinated mechanical handling.

About one-tenth of the total new building construction of record takes place in New York. The country's annual new work has reached a total of ten billions of dollars. Approximately a billion common brick, three to four hundred million face brick, and six or seven hundred thousand tons of hollow tile are sent into New York annually.

Of all the common brick which are delivered to the masons along the wall, from 20 to 22 per cent are broken bats, a loss of over $3.00 per thousand. Many face brick are chipped and structural tile are broken beyond use by the ordinary handling methods, the total loss amounting, in New York alone, to millions of dollars a year.

These materials originate at points where land values are comparatively low and are loaded by labor receiving a lower wage scale than that paid the labor on the construction. As these materials get closer to their final destination, they move over more valuable land and at each stage are handled by more highly paid workmen. At the building, they reach the peak of land values and of the wage scale, and must often be unloaded from trucks and stored in Manhattan's busy streets under permit. It is not, therefore, unreasonable to exact equal or greater efficiency in moving these materials within the building than is required at previous stages of their handling.

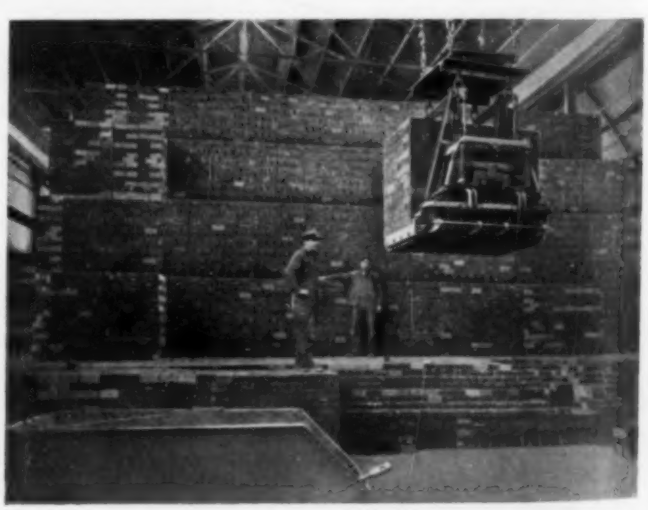
Modern manufacturing, from the raw material to the finished product, is a continuous process even though widely separated plant units contribute parts to be finally assembled at a central point. In some definite degree, the construction industry may learn and benefit by an adaptation of these new methods. Structural steel and concrete materials are today handled so efficiently that their movement may be left out of consideration except as a good example of what can be done in this direction.

MODERN MECHANICAL HANDLING OF BRICK

A number of illustrations show the improvements which have been made in handling common brick at the point of manufacture. The best that three crews on a kiln face could do was to place 50,000 bricks per day by hand. A brick handling fork, however, can pick up and place on a kiln face from 300,000 to 375,000 bricks per day.

The modern method of transporting bricks is to load them into steel bottom-dump containers holding 3,000 bricks each. Twelve containers are fitted into each gon-

Old Method



A Brick Setting Fork

Brick Handling Equipment at the Kiln

dola car, and are hauled to their destination where they are unloaded into trucks from the railroad siding. These steps are illustrated.

In the case of movement by water, the loading is done from kiln to barge by mechanical means, and at destination the brick may be moved from barge to truck by the mechanical brick fork. Movement by hand or by belt conveyors are both more destructive. Studies are now being carried on with a view to transporting the mechanically handled brick unit to the job intact. An adaptation of the container-car method of shipping has been applied to concrete materials. On the construction of the National Milling Company's grain silos at Toledo, Ohio, bulk cement was delivered to the mixer in weatherproofed lime containers. The photograph shows the first car loaded with bulk cement and the second car with brick containers filled with sand and gravel, a fully coordinated process.

Shipping Brick by Rail
Loading a Train of Bottom-Dump Containers—Train to Truck at Destination

SHIPPING TILE IN STEEL CRATES

In 1930 a large container or crate for building tile was developed. This crate holds 15 tons of tile, a truck load, and four such crates will load a flat car. They are rigid and weigh about 3,000 lb. each. Their disadvantages are that on the work, at destination, they must be unloaded by hand and the bulky crates shipped back empty.

Another step in the development of containers is shown in the photographs of collapsible crates. One of these is shown entering a kiln on a hand truck for its 2-ton load of hollow tile. From the kiln to the job no necessity for movement by hand arises. The loaded hand truck is hauled by tractor to the dock side and the crates loaded on the barge deck by derrick cranes. At the port of destination the crane quickly transfers four crates to a waiting truck, which then proceeds to the job. Thus far, tile from these crates have been moved by hand methods to the floor of the building, but the photograph might well illustrate lifting these containers intact from the truck onto an industrial flat car to be lifted by hoist to the wall where needed. For return to point of manufacture, the collapsible crates are folded and stacked in an upright crate.

HANDLING MASONRY UNITS ON THE JOB

On the new Delaware, Lackawanna, and Western Railroad Terminal Warehouse at Jersey City, inspected by members who attended the Annual Meeting, some effective methods were used in handling materials on the job. Gas-electric lift trucks, as shown in the illustration, moved 6,000 lb. of cement direct from the cars to the mixer. Skids of hollow concrete back-up tiles were loaded at the cars, conveyed by a similar lift truck to hoists within the warehouse, taken off the hoist by another truck on the floor above, and conveyed to the masons on the wall. Mixed mortar in skid boxes

Four Crates to a Carload

Fifteen-Ton Crate on a Truck

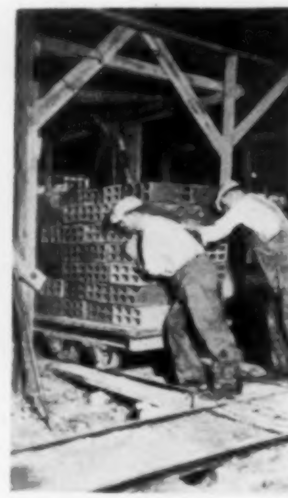
Steel Crates for Handling Hollow Tile

Loading a Side-Dump Mine Car

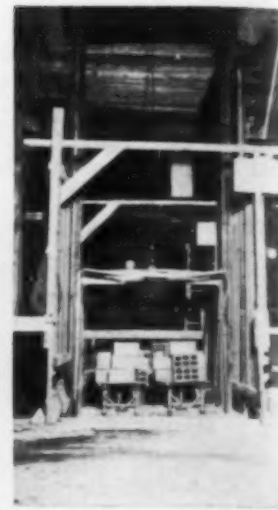
Distribution to the Wall, Sixth Floor

BRICK HANDLING, EMPIRE STATE BUILDING

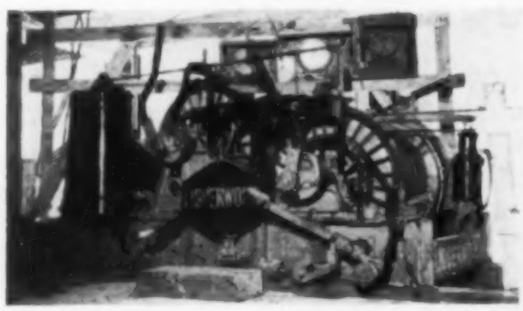
TILE MOVING, EMPIRE STATE BUILDING



By Flat Car



By Wheelbarrow



4,000-lb. Mine Hoist

The Cage

TRANSPORTING WORKMEN, EMPIRE STATE BUILDING

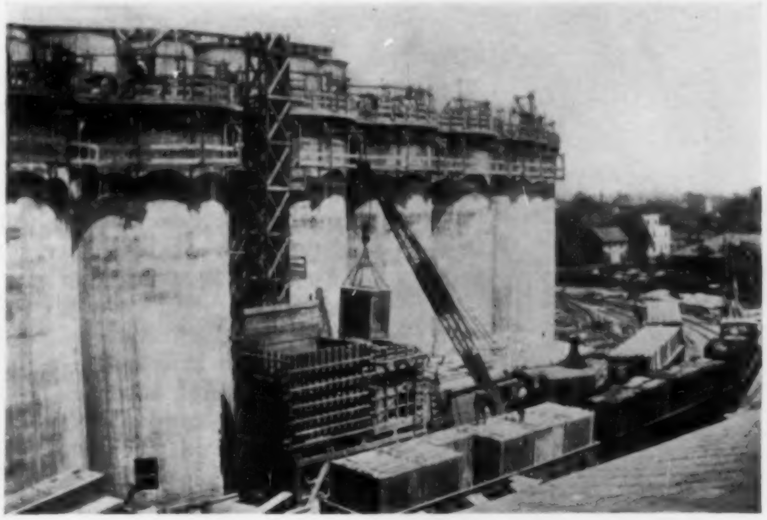
Chrysler Tower, New York

500 Fifth Avenue, New York

TUBULAR STEEL TOWER HOISTS

was moved to the wall in a similar manner. A total of 9,364 tons of these 16-lb. tiles and 2,275 tons of face brick were placed on eight floors that were 846 ft. long and 162 ft. wide, and delivered direct to the masons' scaffolds.

The skid-and-truck method was also found of use in handling many other things, such as window frames and doors and miscellaneous materials that could be stacked on skids and stored until wanted. There was no problem of congested storage or of elaborately scheduled deliveries to avoid it. Lift truck equipment is being rapidly developed in many forms for both light and very heavy loads. It gives promise of wide service in the horizontal moving of materials.



NEW DEVELOPMENT IN TRANSPORTING BULK CEMENT
First Car Carries Cement in Containers, and Second Car, Sand and Gravel

INDUSTRIAL RAILROADS IN EMPIRE STATE BUILDING

More than 80,000 tons of brick, tile, stone, and mortar were to be placed on the 85 stories of the Empire State Building. It was evident that old-style hod hoists, even operating at high speeds, could not complete the job on time. Bulk handling on powerful mine hoists, moving more slowly, required fewer holes in the floors for hoist shafts and was able to deliver the necessary material. Horizontal movements were made on portable industrial tracks.

All material was delivered to the Empire State Building by truck to one of four entrances on the main floor. Sufficient room permitted truck drivers to turn around. Brick, sand, and gravel were dumped into hoppers in the basement, while stone was unloaded by an overhead 4-ton electric hoist operating on an I-beam trolley, from the trucks to flat cars operating on industrial tracks. A photograph shows the electric hoist loading stone slabs onto the flat cars, which were then pushed onto the elevator. The slabs were stored on the floor above their position in the wall and let down by hand winches as needed. Heavy transformers weighing 5,000 lb. were lifted by those material hoists and moved on a flat car.

Bricks were loaded out of the bins in the basement into side-dump mine cars, run onto the elevators, moved along the portable track on the floors to the masons on the wall, and stored on the floor until used. These steps are illustrated. Tiles for the higher floors were handled on flat cars in a manner similar to that used for the stone slabs. Other ordinary wheelbarrow hoists also elevated the tile to the position needed. The first method handled 110 tile per trip, the second 20 tile per trip, an efficiency ratio of 4 to 1.

The tonnage of men handled daily from street level to job and from job to street level was a very appreciable percentage of the total tonnage moved during construction. Before the service elevators could be put into operation, two standard single-drum mine hoists, operating at 300 ft. per min. and equipped with every known safety device, lifted and lowered the men. As rapidly as the steel erection advanced, the hoist heads were moved up.

TUBULAR STEEL TOWER HOISTS

Three pairs of tubular steel hoists erected outside the Chrysler Building handled the materials above the first few floors. Workmen were lifted to their work by a service elevator put into service 15 days after the beams

Crate Entering the Tile Kiln for Loading

Derrick Loading a Truck from a Barge

TILE SHIPMENT WITH 2-TON FOLDING CRATES

were in place. The advantage of the outside hoist is that it permits completion and occupancy of the lower floors as erection on the upper floors proceeds. In the case of the Chrysler Building, 14 floors were occupied

TERMINAL WAREHOUSE, D. L. & W. R. R., JERSEY CITY
Gas-Electric Lift Truck Handling Cement
Back-up Tile and Mortar Movements

before the upper stories were completed. The building at 500 Fifth Avenue had a complete bank of tubular steel hoist towers, which were outside after the first setback. Completion of this prominent uptown skyscraper was accomplished six weeks ahead of contract schedule. On this type of hoist, no loads greater than the usual barrows of material have been customary but it appears practicable to provide for ton lifts.

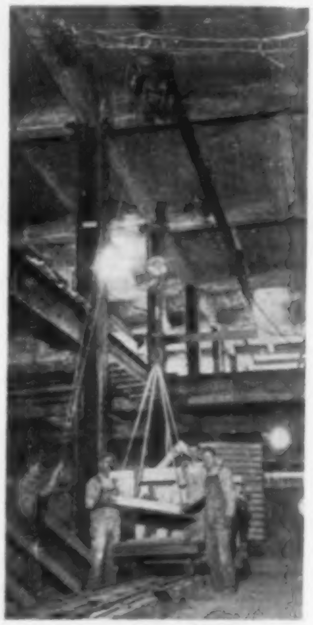
There is one principle that should govern throughout, in the introduction of changes, and it is the obvious and simple one that no movement of materials should be by hand unless that movement adds more value to the product than the mechanical movement. It is unfair to labor to keep it employed in handling millions and thousands of millions of pieces of building materials by piecemeal methods, and then criticize the men for reduced unit production. This means working for speed, under high pressure, with constantly increasing damage to the materials. It is obviously unfair to the client or owner for whom the building is erected to break and destroy the materials, and to expend labor and money on work that does not improve the quality of the building, or its capacity for service.

In summing up, may I refer first to the responsibility that rests upon the construction engineer. Whatever the project under his control, great trust is placed in him for the most efficient and economical utilization of men, money, and materials. Waste of any one of these is abhorrent to the true engineer.

Constant engineering research is being carried on to secure the best utilization of materials with maximum efficiency and least volume. This is largely the work of the structural engineer. An equally efficient utilization of the laborer's time is of equal importance if the construction job is to have complete engineering control.

Safety of the lives of these workmen is, of course, the first factor to be considered, and the safety of their jobs, the continuance of their employment, is insured by applying economics to construction.

A revamping of our present material handling methods is already on the way. The manufacturers and carriers have been at work developing their methods for several years and have proved the value of their efforts. They are continuing to improve and are investing heavily in the mechanization of their equipment and methods. In general, however, the building construction industry has not been active in revamping its methods of handling. It remains largely "standardized" in the use of the ordinary, very inefficiently loaded hod hoist for vertical movement and of the tray wheelbarrow, loaded piecemeal by hand, for horizontal movement of materials.



EMPIRE STATE BUILDING
Loading Facing Stone—16,000 Tons Moved

The examples here given are evidence that better methods can be used. These few have aroused unusual interest in the construction industry, yet what has been accomplished in these instances is but a small portion of the efficiency that can be developed when the manufacturers, carriers, and final users—the builders—work together. Then methods and equipment can be developed which will allow continuous movement direct from maker to user without rehandling and the consequent accumulation of breakage and other damage.

EMPIRE STATE BUILDING
Portable-Track Industrial Railway on the 85th Floor

Federal Bureaus Aid the Profession

Civil Engineers Can Obtain Many Benefits from Government Research

MANY Government agencies are engaged in making systematic studies of the resources of our country. The rainfall and stream-flow data collected by the Weather Bureau and the Geological Survey are generally well known to the profession. With the belief that engineers are not aware of the vast storehouses of facts available in other branches of Government service, the Program Committee was able to obtain representatives from several of these bureaus to inform the engineers in attendance at the Annual Meeting in New York as to how their departments function for our benefit. The papers which were presented on January 21, 1931, "Government Day," are here abstracted to give an idea of how the Government is making itself useful to the profession.

The Geological Survey

By Julian D. Sears

Administrative Geologist, U.S. Geological Survey
Washington, D.C.

THOSE who build for the future welfare of our Nation must have a sturdy foundation of reliable facts; those who plan for progress in engineering accomplishment must follow the guiding track of scientifically determined natural laws. Without these safeguards there will inevitably be groping and chance-taking that may prove both costly and dangerous.

Like several Government bureaus, the Geological Survey offers basic information upon which engineers can build in solving their own specific problems. Within the fields assigned to it, the investigations of the Survey are constantly directed to the discovery of new truths and, where possible, to a recognition of the principles that underlie and govern the facts. Its work is guided by the realization that researches under Government auspices must be scientific in spirit and practical in purpose. The information acquired must then be made readily available for the use and benefit of the public. Facts must be presented, not with any attempt at eloquence, but clearly and, if possible, quantitatively, whether it be in the words of a geologist's report on his findings, the cold figures of stream-flow measurements, statistics of power development, or the graphic representation on a topographic map of the shape and elevation of the earth's surface.

That such information is widely found of value is attested by the Survey's annual distribution of tens of thousands of reports and nearly a million maps. Nor is this information made available only through the formal publications; a vast amount is also given out in replies to many of the 200,000 letters yearly received. The Geological Survey is a fact-spreading as well as a fact-finding agency.

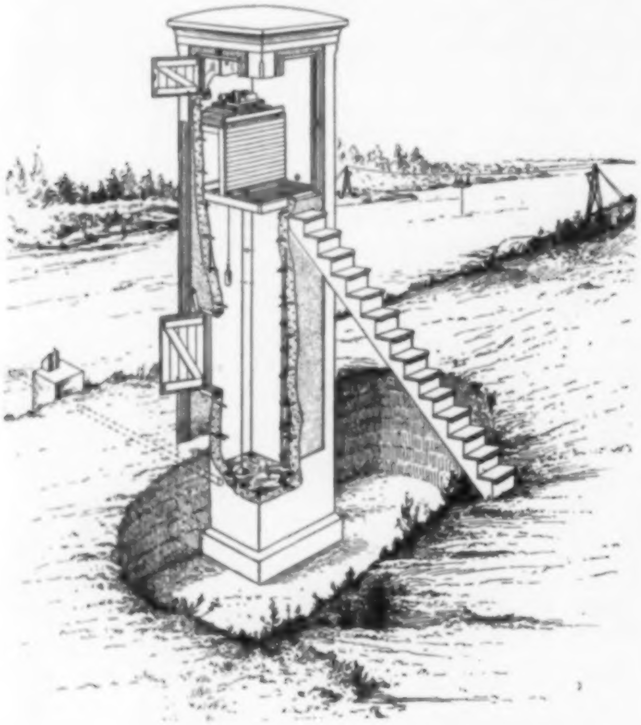
Mineral Resources Examined

More than half a century ago, when the Geological Survey was organized to take over the functions of four pioneer surveys, one of the chief tasks assigned to it was to examine and report on the mineral resources of the public domain. Each year its geologists have gone out into widely scattered areas in the United States and, as part of the results of their work, have brought back additional information on the occurrence, quantity, quality, and availability of deposits of metals, fuels, or non-metals—iron, copper, gold, petroleum, coal, potash, phosphate, and dozens of other minerals that are not only useful but absolutely essential to our present-day life.

This continuous inventory of the Nation's mineral resources has qualified the Survey as an adviser on the raw materials needed to satisfy industry's constantly shifting but ever increasing demands. The steady advances in processes and methods of manufacturing, the scrapping of the old and obsolete, the installation of new and improved types of machines, and above all the changes in the ways and standards of living, have multiplied many fold our consumption of the metals, fuels, and structural materials

Mapping the Grand Canyon, Arizona

that come out of the earth. True, the United States has been wonderfully endowed with most of these resources, but already our rapidly mounting consumption has brought real concern for the adequacy of future supplies of some of the most essential minerals, without which the brain children of America's engineers can get no further than lines on a blueprint.



STREAM-GAGING STATION AND RECORDING GAGE

Actually, the continuance of industry and of the engineer's share in it is dependent upon the assurance of adequate supplies. To this assurance the Geological Survey contributes directly through its findings of new deposits and indirectly through its more general geologic work. For example, by determining the laws that govern the deposition and segregation of ores, the Survey assists even the geologists and mining engineers of private companies in finding new deposits.

THE TWENTY-YEAR PLAN OF TOPOGRAPHIC MAPPING

Topographic mapping was begun almost immediately after the organization of the Survey, because the topographic map was recognized as the best and, in some cases, the indispensable base upon which to depict the geology of the regions studied. From the outset it was planned to cover the entire United States with a topographic atlas, to be prepared and published in units representing quadrangles based upon latitude and longitude. At first the standard unit was the 1-deg. quadrangle, with mapping on a scale of 1:250,000, or about 4 miles to the inch. Today the standard scale for most parts of the country is 1:62,500, or about a mile to the inch. A still larger scale is used in areas of outstanding requirements.

In the meantime, the standards in accuracy, both of the control for location and elevation and of detail in the contour sketching, have steadily risen. The increase in scale and the improvment in accuracy and detail have been partly the cause and partly the effect of the ever growing number of uses to which these maps are put. For today they are used, when available, by every kind of person for every sort of purpose, from a boy scout planning his afternoon hike to the engineer designing a mammoth dam, or an Army officer directing gun-fire.

It is, however, unnecessary to describe to engineers either the nature or the value of topographic maps. On the other hand, the engineers themselves have taken a leading part in urging upon lawmakers, national and local, the need for more liberal appropriations to speed progress in mapping. The American Society of Civil Engineers was one of the strongest influences that led Congress, in 1924, to pass the Temple Act authorizing completion of the project in 20 years.

In the fiscal year of 1930, the Geological Survey mapped in the continental United States, exclusive of Alaska, nearly 17,000 square miles by new survey, over 1,000 square miles by revision, and nearly 4,000 square miles by resurvey (mostly in areas previously surveyed on a smaller scale). Although, as contrasted with the preceding year, there was a notable increase in the area of new surveys, yet the year's work added only 0.6 per cent to the proportion of the country that has been mapped—not very rapid progress in the great task.

The country as a whole is now 44.2 per cent mapped, but it must be recognized that the maps of even a considerable part of that area, made in the early days, are quite inadequate for present-day purposes, either because their scale is too small; their basic control less accurate than is now required; or their information as to roads, railroads, cities, and other works of man too far out of date to be of practical usefulness.

AREAS TOPOGRAPHICALLY MAPPED BY THE U.S. GEOLOGICAL SURVEY To July 1, 1930

For several years, the greater part of the funds appropriated to the Geological Survey for topographic mapping have been restricted by law to use in cooperation with states and municipalities, the policy being to map at wholly Federal expense only those areas, such as national parks and national forests, in which the Federal Government has a predominant interest. State and municipal

cooperating agencies are now contributing about half a million dollars annually, and last year the total funds available to the Survey for topographic work exceeded a million and a quarter dollars. However, this total is far below the amount which, during the hearings on the Temple Bill, the Board of Surveys and Maps estimated would be required annually by 1930 in order to complete the project in 20 years, and progress is correspondingly slowed down.

WATER RESOURCES

Another function of the Geological Survey that yields results of prime importance to engineers is its investigation of water resources. With this country's rapid growth in population and industry, the demand for water is constantly increasing, and the limiting effects of water on many important activities have become ever more apparent. The vital need for control of surface waters has been notably accentuated by the results of several disastrous floods in widely separated areas, and other phases of the problem of water have been emphasized by the widespread drought of the past year. Water is now recognized as a limiting factor, not only in irrigation, but also in the location and capacity of industrial plants and in the growth of cities. The supply of water sets the limit of electric power, whether from steam-power plants or water-power plants.

It is natural, therefore, that from all parts of the country there are coming more frequent and more insistent demands for authoritative information in regard to the quantity, quality, availability, and control of both surface and ground supplies of water. To meet these demands, the Survey is studying the country's water resources under four principal headings—surface water, ground water, quality of water, and power resources.

In its investigation of surface waters it now operates nearly 2,500 gaging stations on streams all over the country, for obtaining continuous records of discharge. Engineers, more than any other users, can appreciate the necessity for starting to obtain such records long before projects dependent on the water are to be begun; for having the readings taken and calculated accurately by standardized methods; and, because the flow of any stream fluctuates so widely from year to year or even from month to month, for having the records obtained continuously over a long term of years rather than sporadically or for a brief period.

Like the topographic mapping, the investigations of water resources are carried on largely in cooperation with the states, and the total funds available from all sources are about the same—a million and a quarter dollars annually. This year, for the first time, Congress has recognized that the Federal interest in this work fully warrants dollar-for-dollar cooperation and has appropriated funds sufficient to meet the state offerings on that basis.

MINERALS AND OIL ON PUBLIC LANDS

Another activity of the Survey, while of somewhat less general application to engineering problems, is of real value to the Nation. This is the supervision of development operations on public mineral lands under lease by petroleum and mining engineers in its employ. Their duty is not only to enforce the leasing laws and to insure correct payment of rents and royalties, but also to advise the operators on proper methods, to help them to make profits, to safeguard the lives of workers, and to protect the mineral deposits from waste or damage. Their aim is true conservation—which means efficiency, avoidance of waste, and wisest use.

Indeed, is not such conservation the aim and task that all engineers have in common? For the engineers of America must devise ways and means of using most effectively both capital and labor in the utilization of natural resources; they must harness the forces of nature to do man's work. To provide some of their working tools, some of the foundations upon which they may build, some of the guiding principles by which they may pass to new achievements, is a duty of the Geological Survey. The information it has acquired is at their service, whether through printed maps and reports, through letters, or through personal conferences, and all those who have problems within its fields are not only invited but urged to avail themselves of whatever help the Survey can give.

The Bureau of Standards

By GEORGE K. BURGESS
DIRECTOR, BUREAU OF STANDARDS, WASHINGTON, D.C.

MANY questions of interest to the profession of civil engineering are the concern of the Bureau of Standards. To consider first matters relating to measurement, the bureau is equipped to certify lengths from the shortest measurable up to 50 meters. For this purpose it possesses a tunnel, the temperature of which can be adjusted between 8 deg. cent. (46 deg. fahr.) and 40 deg. cent. (104 deg. fahr.). Tapes and wires for the use of surveyors and geodetic engineers can be measured and their coefficients of expansion determined.

With respect to angles, the bureau has recently installed equipment for circles, permitting their graduation and calibration to 1 sec. of arc (equivalent to $^1/_4$ in. at one mile). Within this accuracy it has recently graduated several circles for the Coast and Geodetic Survey. This is a service which has not heretofore been available in this country. As to gages, the bureau is in a position to calibrate length gages, as well as ring gages, from the smallest up to the largest (24 in. in diameter) required by the oil well industry, and maintains the master gages used by that industry.

In regard to measuring instruments of interest to civil engineers, the bureau has developed several types of strain gages, some of which are widely used, such as the telemeter of McCollum and Peters used in measuring deformations in dams, bridges, and other structures.

TAPE-TESTING TUNNEL OF THE BUREAU OF STANDARDS
Precision Geodetic Comparator on the Left

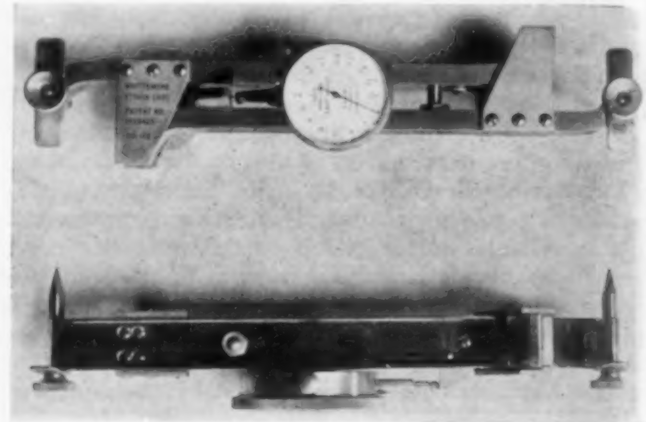
The Whittemore flexure-plate strain gage has increased the facility with which hand strain-gage readings can be taken. It was developed for use on the Stevenson Creek Dam and has since been used on a considerable number of important structures, including the Sydney Harbor Bridge at Sydney, Australia, the new Hudson River Bridge, and others.

ACCURATE MEASUREMENT OF STRAINS MADE POSSIBLE

The Tuckerman optical strain gage, which was developed in connection with a detailed study of riveted joints for the Navy Department, has brought within the reach of the average engineer the possibility of convenient measurement of strains to an accuracy of one-millionth of an inch per inch. Civil engineers are familiar with its use on Professor Begg's model of the Stevenson Creek Dam. It has proved increasingly useful in our laboratory and is now being used by the Bureau of Reclamation on model studies for the Hoover Dam.

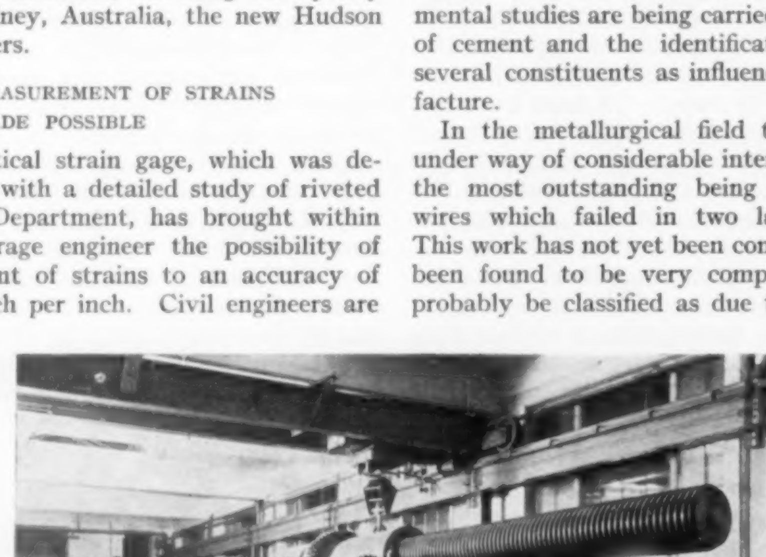
There has also been developed a new and very sensitive type of recording instrument for detecting and measuring the horizontal component in earthquake movements, and progress has been made in designing a vertical component instrument.

To aid in obtaining uniform test methods for the cement produced in the country, the bureau set up, in cooperation with the American Society for Testing Materials, something over a year ago, a reference laboratory for the control of cement testing throughout the country. Some 200 laboratories have already taken advantage of this service, by means of which testing apparatus and methods are coordinated. Several investigations are under way relating to cement and concrete admixtures and, in cooperation with the Portland Cement Association, fundamental studies are being carried out on the composition of cement and the identification and function of its several constituents as influenced by methods of manufacture.



WHITTEMORE STRAIN GAGE
Detects Stresses of 300 lb. per sq. in.

In the metallurgical field there are several studies under way of considerable interest to engineers, perhaps the most outstanding being an examination of the wires which failed in two large suspension bridges. This work has not yet been completed; the problem has been found to be very complex. The failure should probably be classified as due to stress-corrosion of the material under very severe heat treatment.



EMERY HIGH PRECISION TESTING MACHINE
Capacity 2,300,000 lb. in Compression, One-Half This Amount in Tension

BEHAVIOR OF RAIL STEELS STUDIED

Several questions relating to the properties and behavior of rail steels, of interest in connection with their manufacture, are now being studied. The problem of corrosion is being attacked from several points of view, including development of tests. For several years a cooperative investigation has been under way to determine the behavior of metal pipes for underground service. This has recently been ex-

tended to include metals coated with various kinds of rust-resisting materials.

One of the most important recent developments relates to the welding of structures, and the bureau has been very active the past year, in cooperation with others, in developing and carrying out tests for large welded members of various types to determine the practical limits of design. For example, investigations of welded shelf-angle connections for columns, bridge pedestals, bases for subway columns, and splices for H-section columns, all fabricated by bare-electrode metallic arc welding, gave encouraging results and showed that, when properly designed, the strength of these members was ample. It appears probable that, for structures of this kind, periodical qualification of welders is adequate to insure uniformly satisfactory welds.

Also at the laboratories of the bureau are testing machines for determining the strength and other properties of fabricated structural elements, such as steel columns and girders. The hydraulic compression machine, having a capacity of 10,000,000 lb., is said to be the largest testing machine in the world. The Emery precision testing machine has a capacity of 2,300,000 lb. in compression and half this value in tension. Specimens having lengths up to 24 ft. can be tested in it.

To Aid in Designing Steel Columns

One of the most important problems of the engineering profession is the design of steel columns. I think it can be said, without fear of contradiction, that we know less about columns than about any other widely used structural members. Because of the importance of this problem to the people of the United States, the bureau was glad to cooperate about 20 years ago with the Column Committee of the American Society of Civil Engineers by testing in the Emery machine a large number of full-sized steel columns of several different designs.

Column investigations, ranging from small tubes used in airplanes up to columns which taxed the capacity of our largest testing machine, have formed a considerable portion of the research work of this laboratory. In 1926 we published the results of an extensive program of tests on H-section riveted columns built up of plates and angles and similar solid rolled H-section columns. In these short sturdy columns it was found that the strength depended very greatly upon the yield point of the material, leading to the conclusion that very appreciable savings in structures were possible if steel having a high yield point was used.

Structural Clay Products Investigated

In association with several industries interested in heavy clay products, including terra cotta, common brick, and face brick, the bureau has under way several programs relating to strength of walls using these materials, and in a paper on "Strength of Clay Brick Walls," were given the results of two years of work on the effect of workmanship, mortar, design, and brick strength on the strength of masonry. It is interesting to note that a number of the principal building codes in the United States have recently based their values for permitted loading of brick masonry on the results of these tests. The main topics in the field of structural clay products at present being studied are: (1) bond strength of mortar and units; (2) durability of bond; (3) properties of units; (4) weathering of units; and (5) causes and prevention of damp masonry.

Chemical Heat in Setting Concrete

Construction of the Arlington Memorial Bridge, in Washington, D. C., has given an opportunity to study in detail several questions of interest. A special problem difficult to analyze was that resulting from the unequal thermal and elastic properties of the massive granite facing material and those of the supporting 177-ft. concrete arches.

During the early hardening of the concrete in the arch barrel, the heat evolved by chemical reactions caused an increase in the temperature of the concrete of from 25 deg. fahr., in a portion of the barrel 2.25 ft. thick, to over 60 deg. fahr., in portions 5 ft. thick. In one portion the temperature of the concrete when placed was 75 deg. fahr., but rose to 140 deg. fahr. in 30 hours. In general, the maximum temperatures occurred within from 24 to 36 hours after placing.

The time required to dissipate the major part of the chemical heat and to reduce the temperature of the concrete to nearly normal varied from about 7 days for the thinner portions to over 15 days for portions 5 ft. thick. The deflections of the free arch barrel, produced by temperature changes, correspond closely with those predicted by the theory of elasticity, with a value for the coefficient of expansion of the concrete of six-millionths per degree fahrenheit.

For designers wishing to avoid extreme temperature changes by building their structures in blocks that are keyed together after the dissipation of the chemical heat, these temperature records are of use in estimating the time which should elapse between the construction of the blocks and the placing of the keys. The records also give information of value in making estimates of the ranges in temperature that may occur in structures. They indicate that, for concrete construction built during hot weather, the highest temperatures during their life will be those at the time the concrete is hardening.

Building Code Requirements Studied

Research papers have been published covering such topics as fire resistance of hollow tile and brick masonry, sound resistance of brick masonry, strength and water absorption of brick, weathering of brick, behavior of architectural terra cotta, and strength of brick and hollow-tile masonry, as well as numerous papers on the particular properties of units. There has recently been installed a new furnace equipment permitting the study of fire resistance of walls of any desired thickness, and of an area up to 11 by 16 ft. Also under way are fire resistance studies of various types of floors, such as steel, concrete, gypsum, and their combinations.

A brief fire inspection manual is now being prepared which it is expected will be made generally available after it has stood the test of use by the various inspection groups for a sufficient period.

The subject of wind pressure on structures has also been given considerable study at the bureau, as well as the heat and sound insulating properties of building materials.

Our Building Code Committee is composed of five engineers, one architect, and one contractor. Four are members of the American Society of Civil Engineers. The committee is working toward the completion of a set of building code requirements suitable for use in municipalities throughout the country. It has already issued six reports dealing with such subjects as code arrangements, live-load assumptions, and allowable working stresses in building materials.

The committee's method of procedure is to investigate all sources of information and then issue a tentative report which is distributed widely for criticism. When there are doubtful points, the committee asks the bureau to perform experimental work, the results of which may be used as a guide. The broadest possible basis of collective judgment is sought before issuing conclusions.

At the request of the Sub-Committee on Plumbing, the bureau has undertaken to find out the facts about plumbing systems in high buildings. One of its men has conducted preliminary work in New York City, where he has placed measuring instruments in the drains of several high buildings. This field work will be supplemented by experiments upon a stack 100 ft. high, which will soon rise upon the bureau grounds.

Another study of great importance to civil engineers, the determination of a uniform method of reading testing machines, is under way. Calibrated proving rings for users of large testing machines are beginning to be available. For hydraulic engineers, current meters have been tested for a number of years. At a later date an account of the new hydraulic laboratory and of the problems the bureau expects to study there will be available.

The Bureau of Public Roads

By THOMAS H. MACDONALD
CHIEF OF THE U.S. BUREAU OF PUBLIC ROADS
WASHINGTON, D.C.

FROM the date of its creation in 1893, as a branch of the U.S. Department of Agriculture, until 1912, the functions of the U.S. Bureau of Public Roads were those of investigation and education only. In the latter year, however, the bureau was charged with administration of the construction of Federal post roads, provision for this being made to the amount of $500,000 by the Post Office Appropriation Act for the fiscal year 1913. The administrative experience thus acquired by the bureau, together with its long contact with the development of the movement for road improvement, led in 1916, when the principal of Federal aid for road building was inaugurated, to its designation as the Federal agency to cooperate with the highway departments of the states. The work then begun has grown in importance and volume, until it now constitutes the largest of the bureau's activities.

This work is carried on in cooperation with the state highway departments. Total authorizations for the work, including authorization for the fiscal year 1933, amount to $1,290,000,000, and the annual authorization is now $125,000,000. In addition to its cooperation with the states, the bureau supervises major road work in the national forests and parks.

The bureau has never looked upon itself as an agency of research in the field of pure science. The central object, underlying all of its researches, is the devising of ways by means of which highway transportation may be made more efficient. The aspects of physical and economic phenomena investigated are studied by no other Government agency, for the bureau studiously avoids any work which can be more advantageously done by other governmental agencies. Its interest, however, is always held by application of a subject to roads or to highway transport.

Perhaps the most generally useful of the physical researches of the bureau is that dealing with the properties of soils in relation to their suitability as subgrades and foundations for road surfaces and structures. On the basis of the facts already developed in this field, the bureau has proposed a general classification of soils with respect to their efficiency as subgrade and foundation materials; and by further researches it is providing the means of closer definition.

Similarly useful are the results of studies of the distribution of pressure through earth fills, resulting from the application of concentrated loads at the surface and the pressure of earth on culvert pipes laid under various conditions. These studies of the distribution of pressure through earth fills not only resulted in the determination of governing laws, but also, as a by-product, in the development of a pneumatic pressure cell, known as the Goldbeck Soil Pressure Cell, which, when embedded in an earth mass and connected by tubing to the external recording gage, is capable of measuring the static pressure applied to it with an accuracy of 0.1 lb. per sq. in.

MOTOR TRUCK IMPACT INVESTIGATIONS UNDERTAKEN

For more than ten years the bureau has been engaged in a study of the intensity of impacts delivered to road surfaces by motor trucks and other vehicles. This work has resulted in a mass of conclusive data with regard to the intensity of such impacts in relation to the weight of the sprung and unsprung loads, the effects of spring stiffness, wheel design, speed of vehicles, road roughness, the relative cushioning properties of solid, pneumatic, and cushion tires and, to a certain extent, the effect upon road surfaces.

Of the instruments and apparatus employed in this

work, four were developed for the special purpose by engineers of the bureau. These are: (1) a practical machine for applying impact blows of varying intensity; (2) an instrument for the direct measurement of impact forces by the deformation of small copper cylinders calibrated under static load; (3) a space-time recording device for the graphical measurement of deceleration of motion; and (4) a coil spring accelometer, useful for the same purpose.

STUDIES OF CEMENT CONCRETE

Included in the items of information resulting from studies of the properties of cement concrete are measurements of the expansion and contraction of concrete when subject to temperature and moisture change; determinations of the effect of alternate freezing and thawing, both during and subsequent to the setting period; determinations of the effect of time of mixing in full-size paving mixers on the strength and uniformity of the product; the effect of alkali salts in soil and water on concrete with which they come in contact; and the means of protecting the concrete against alkali attack by bituminous paint coats.

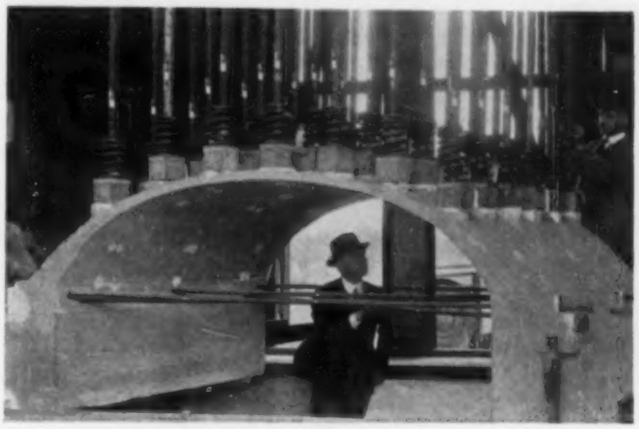
Among the most useful of the bureau's studies of this character are those dealing with the effect of the kind and proportion of coarse aggregate upon the strength and density of the resulting concrete. These investigations, not yet entirely completed, give promise of supplying, when fully analyzed, new knowledge of the effects of these concrete factors. This would be comparable in importance to the discovery of the effects of the water-cement ratio.

Practically all concrete pavement curing methods thus far proposed have been tested in an investigation which was carried out on a section of Tennessee highway 15 miles in length. One-half of the pavement, throughout the entire length of the road, was cured with wet earth, and the character and behavior of the concrete thus treated have been taken as the standard of comparison by which the relative effects of other curing methods used on the other half of the pavement have been determined. The several bituminous methods—surface applications and admixtures of calcium chloride, sodium silicate applications, ponding, wet burlap, sisalkraft coverage, and tar paper laid on the subgrade—are all included among the methods tested.

TESTING YADKIN RIVER BRIDGE, NORTH CAROLINA
Water-filled Tank Used for Movable Load; Test by North Carolina State Highway Commission, Cooperating with the U.S. Bureau of Public Roads

CONCRETE PAVEMENT AND BRIDGE SLABS

As the result of 15 years of continuous effort to rationalize the design of concrete road slabs, the bureau has experimentally evaluated practically every factor involved except the important one of subgrade support. Our experiments have yielded all necessary data with reference to the contraction, expansion, and warping of the slab under various conditions of temperature and moisture. Differences of temperature between the top and bottom of the slab, occurring daily and seasonally, have been accurately measured, and reasonable design limits have been determined. The coefficients of friction between the slab and various subgrades have been determined with all necessary accuracy, and the distribution of pressure to the subgrade from loads applied at various points on the pavement has been measured quite adequately by soil pressure cells. The related effects upon pavement stresses of joint spacing, subgrade friction, and kind and position of steel reinforcing have been fully explored; and, finally, the distribution of stress induced in the slab by applications of both static loads and impact forces has been studied to a definite conclusion, qualified only by the as yet undetermined influence of subgrade variation.



TESTING REACTIONS OF A SKEW-ARCH BRIDGE
U.S. Bureau of Public Roads

A useful bit of information to bridge designers is the determination of the distribution of abutment pressures for skew arches; and the tests of the full-size, open-spandrel concrete arch bridge over the Yadkin River. These, conducted in cooperation with the North Carolina Highway Commission and with the advice of representatives of the Society, in 1927, are perhaps already familiar to most readers of this paper.

ROUTINE TESTS OF ROAD MATERIALS

For 25 years the bureau laboratories have continuously carried on tests of road materials of all kinds submitted for the purpose from every part of the United States. The records of these tests are complete and available to anyone who wishes to consult them.

Another field of the bureau's research work is that concerned with road construction processes and equipment. Such studies have thus far dealt mainly with

grading and with concrete and bituminous concrete pavement construction, although less extensive studies have also been made of quarrying operations and bridge construction. In this work, stop-watch studies were made of a very large number of actual construction projects in the effort to discover the lost time and waste motion that may exist in the various processes as commonly practiced. The principles evolved for road construction are equally applicable to construction outside of the highway field, and all engineers should acquaint themselves with the very interesting reports that have been published.

ECONOMIC AND STATISTICAL DATA AVAILABLE

The highway traffic and transport surveys, conducted by the bureau in several states in cooperation with state and county officials as the basis for highway system planning, provide another source of data that may be useful to a much wider group of engineers than those concerned directly with highway planning and traffic control. The bureau publishes a monthly journal of highway research, called *Public Roads*, in which an endeavor is made to report regularly all available information in regard to the various lines of investigation under way. The publication can be obtained on paid subscription from the Superintendent of Documents for $1.00 per year.

Certain classes of information, not published in full in the periodical, are published in special reports and bulletins, which are generally available in sufficient numbers to fill ordinary demands. Furthermore, the bureau will be glad at all times to furnish full information concerning its work to anyone interested.

The latest tests for very large columns were on half-size models of portions of the columns of the Hudson River and Kill van Kull bridges, made in cooperation with the Port of New York Authority. This investigation determined the increase of strength gained (about 40 per cent) by encasing plain carbon and silicon steel columns in concrete.

The Corps of Engineers of the Army

By LYTLE BROWN
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
MAJOR-GENERAL, U.S.A., CHIEF OF ENGINEERS

VERY early in our history—during the Revolutionary War, in fact—General Washington and Alexander Hamilton, two men of the broadest vision that we have had, saw that one of the greatest defects in the army of the Colonies was a lack of technical men, especially engineers and artillerists. One of the last letters that George Washington ever wrote was in support of the establishment of an academy for engineers and artillerists.

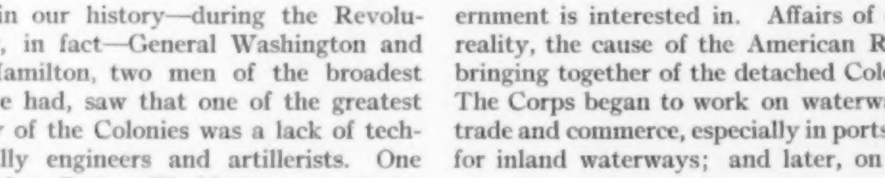
Shortly after, in 1802, the Military Academy at West Point was established, one of the first, if not the very first scientific school to open in America; and it was very natural that the first available engineers that we had should come from there. Previously, this country had been forced to draw on foreign nations, especially France, to get engineering talent.

Very soon the Corps of Engineers started to do certain civil work in connection with commerce, which is one of the principal subjects that the Federal Government is interested in. Affairs of commerce were, in reality, the cause of the American Revolution and the bringing together of the detached Colonies into a nation. The Corps began to work on waterways, along lines of trade and commerce, especially in ports; then on the rivers for inland waterways; and later, on canals.

ORGANIZED FOR WATERWAY, PORT, AND HARBOR WORK

Our work on waterways is handled by a special organization. A few members of this belong to the military service but the majority of the technical men are civilians. The country is divided into 44 districts, the district offices being in the principal cities.

The districts are grouped into eight divisions under division engineers, who supervise and closely coordinate their work. These divisions are so arranged that they take in related works. They are, the North Atlantic, the South Atlantic, the Gulf, the Lower Mississippi, the Upper Mississippi, the Great Lakes, the



ORGANIZATION CHART

North Pacific, and the South Pacific divisions. The district offices come most into contact with the public.

Authority for waterway improvements does not originate with the Corps of Engineers. In fact, very little originates even with Congress. Proposals for improvements start with the people themselves. If the members of a community want certain work done, they take the matter up with their Congressman. He hands it over to the proper committee in Congress, or introduces a bill which is referred to the proper committee as a routine matter. The committee, in turn, passes the request along to the Secretary of War or to the Chief of Engineers, for investigation.

STARTING A SURVEY

Like all other sensible investigations of the sort, this starts with a preliminary examination, on which very little money is spent. It involves no surveying as a rule, but advantage is taken of all the surveying that has been done, and of all the information that has been previously collected, no matter by whom.

Possibly this first study may be sufficient to show the proposed work to be unfeasible or inadvisable, and a preliminary report, very general in its nature, is made to this effect. If, however, the desired improvement seems to have possibilities, a survey may be ordered. Enough work is then done in the way of surveying to bring it to what is called project form, that is, a general plan of the proposed work is drawn up so that it may be passed on to Congress.

Such a report goes from the Secretary of War to the Speaker of the House, and is referred to the River and Harbor Committee. If finally approved by Congress, it comes out as an adopted project. However, work on it cannot be started yet. Something else must be done—an appropriation must be made. That is handled by an entirely different committee in Congress, an Appropriation Committee. Although the Corps may have a vast amount of work authorized, none of it can be undertaken until money is appropriated for it.

The survey reports are printed in the form of House or Senate documents. While they may not contain engineering information in such detail as may be required by other engineers, this information is available and can be obtained from the district office that made the survey and the preliminary report.

Recently, since 1927 or thereabouts, Congress has ordered a survey of practically every stream of any importance in the United States, with a view to determining the feasibility of using the water for navigation, power development, flood control, and irrigation. Some sixty of these surveys have been completed, and there are about two hundred in all to be made. When they are all in, probably by 1932, there will be a very thorough prospectus of every important stream in the country.

HARBOR JURISDICTION

The War Department has jurisdiction over harbor improvements and the Secretary of War may establish pierhead and bulkhead lines—that is, the lines fixing the channelward limits of pierheads and of solid fill, respectively. They are so laid out as to prevent undesirable encroachments upon the fairway. This is the reason why harbor lines are established in important harbors such as New York, San Francisco, and Boston, and of course they must be adhered to or the law is violated.

Through the agency of the Corps of Engineers, the War Department supervises the placing of all structures

BONNET CARRE SPILLWAY

in or over navigable waters and the removal of obstructions therefrom. Congress has provided a standing appropriation under which the Engineer Department removes wrecks if they interfere with or menace navigation.

The permit for a dam for power purposes is issued by the Federal Power Commission; but the Chief of Engineers must first certify what effect the project will have on navigation. The building of a bridge, or of a dam for other than power purposes, is unlawful unless prior legislative consent is obtained and the plans are approved by the Chief of Engineers and the Secretary of War before construction is commenced. Congressional consent must be obtained for bridging an interstate waterway and state consent for others. Wharves, revetments, and other structures, dredging and dumping, or other work in navigable waters must be authorized by permit from the Secretary of War on the recommendation of the Chief of Engineers, practically invariably after an investigation by an officer of the Corps. Applications for approval of plans and for permits should be made to the nearest district engineer, Engineer Department at Large.

MISUNDERSTANDING HARMFUL

There is a great deal of misunderstanding about these permits, which sometimes works much harm to applicants and costs them large sums of money. In order to get a permit for a bridge it is not necessary to furnish detailed plans, but only simple drawings showing location and horizontal and vertical clearance in accordance with a standard form, in order that the effect on navigation may be judged.

The Corps has a special survey office located at Detroit for surveying and mapping the Great Lakes and connecting waters to the Coast and Geodetic Survey. A Military Mapping Division furnishes maps to the Army, in case of need, of any part of the United States and of any other location where the Army may find it necessary to carry on operations. Military maps of the United States are based, in general, on the maps of the Geological Survey, which are so comprehensive that they are sufficient for almost any military purpose.

An immense amount of information is contained in the files of the various district offices, and any factual information whatever that is in the possession of the Corps of Engineers is available to any citizen of the United States. But in matters of opinion more care must be taken. On nearly every large project there are two factions, one fighting for it and one against it. Therefore opinions are not given by the District Engineer offices, but by the Chief of Engineers, who does not live in the district, and whose views, therefore, are not unconsciously affected by local associations.

THE CORPS AND THE CIVIL ENGINEER

The Engineer Corps cannot get along without the assistance of the civil engineers of the country. A large number of our assistants are civil engineers; they have most of the technical knowledge that we deal with and we depend upon them at all times. The comparatively few men that we have from the Army are mostly in executive positions. In accordance with the law passed last year, the Chief of Engineers can get the best technical advice that exists in this country, no matter where it is, and he proposes to take advantage of that whenever he feels the need for it. There will be many times when he will feel that need.

While the military engineer may not be needed very much today, or even tomorrow, there may come a time, as in the past, when he will be essential. The younger civilian engineer would be particularly dependent upon him for guidance in adapting his knowledge to military uses. For that reason we must be well acquainted at all times, we must know one another, and be willing to cooperate with one another so as to have the work done most efficiently and with the least friction. One great advantage which army engineers gain from work in connection with the civil needs of our government is acquaintance with the construction and engineering forces of the country, thus facilitating work with them in emergencies.

U.S. Coast and Geodetic Survey

By R. S. PATTON
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
DIRECTOR, U.S. COAST AND GEODETIC SURVEY

THE Coast and Geodetic Survey is more than a century old. Created by Act of Congress in 1807, field work was actually begun in 1816. Its scope was at first limited to surveys and subsequent operations necessary to make charts for the guidance of mariners along the Atlantic Coast, but it has gradually been extended, both geographically, to keep up with the growth of the Nation, and functionally, to include additional services for which a public demand has arisen and which bear a logical relation to the work being done.

TYPICAL PINNACLE ROCKS
The Wire Drag Locates Such Pinnacles When Submerged

Its present functions, therefore, defined in terms of the products which it supplies for the use of the public, consist of: (1) the nautical chart; (2) related nautical publications; (3) control surveys in the interior; (4) tide and current surveys and data; (5) terrestrial magnetism, investigations and data; (6) seismology, investigations and data; (7) airway maps; and (8) technical work for other Federal agencies.

However, the Coast and Geodetic Survey is not satisfied that a wealth of data should exist in its archives. It realizes that, to the average layman, the many Federal agencies constitute such a huge and complicated machine that he frequently despairs of locating that particular information which satisfies his own needs. Therefore, the Survey has long endeavored to inform the public, and particularly the engineering public, of the lines along which it can be of service.

SERVICES RENDERED

Basically, there are three ways in which the Coast and Geodetic Survey can serve the engineer:

1. By furnishing him with data which he can use to advantage in those operations in which engineering practice is standardized.
2. By placing at his disposal its specialized knowledge and experience in certain fields within which practice is not yet adequately standardized.
3. By further research in certain of the physical sciences which constitute the foundation on which the art of engineering must rest, and within which greater scientific knowledge is needed for the advancement of engineering practice.

In the detailed discussion which follows, these three factors will be treated as necessary with respect to each project.

TOPOGRAPHICAL STUDIES

Charts published by the bureau cover the seaboard of the United States and its possessions. They are con-

structed with a refinement of detail and printed by methods which reduce paper distortion to a minimum, so that distances and directions can be scaled with an accuracy not attained in general maps. The principal criticism which has always been directed against the Coast and Geodetic Survey is that it does its work too well, and consequently at too great a cost. The nautical chart consists of a framework of geodetic control supporting detailed topographic and hydrographic surveys, and containing tidal and magnetic data.

For the most part, the topography executed by the Survey is limited to a strip of the coast only a few miles wide, but extending along the entire seacoast, around bays and up rivers to the head of navigation, with a few exceptions. As a special undertaking, however, the bureau has surveyed wide areas, such as the entire Virgin Islands, the Mississippi River delta, and the southern part of the Gulf coast of Florida. These surveys are made on scales of from 1:10,000 to 1:20,000 except where, for special reasons, they are made on larger scales. Anyone wishing detailed information regarding the topography of any charted area not shown on the chart will do well to write the Survey Office requesting photographic copies of the field sheets, which can be furnished at a nominal cost.

On a scale of 1:10,000, a distance of one meter on the ground is equivalent on the map to the width of a fine line. It follows, therefore, that one meter should be taken as the upper limit of accuracy in the plane table sheet, and ten meters is a fair approximation of the average upper limit of probable error. Only to a minor extent are these inaccuracies cumulative as, almost without exception, the topographic work has been controlled by a network of triangulation spread over the area to be surveyed.

HYDROGRAPHIC DATA COLLECTED

Hydrographic data on the charts consists of accurate depth measurements of the water area, all reduced to a common plane of reference, which bears a definite relationship to some fixed state of the tide, usually mean low water or mean of the lower of the two low waters when there is a considerable difference in the height of the two daily tides. In thoroughly surveyed areas, the soundings are taken so close together in all directions as to show all important changes in the depth and character of the bottom.

Pinnacle rocks, submerged by navigable waters, are located by the wire drag. The sonic depth finder, an application of the radio and sound transmission through sea water, is revolutionizing hydrographic surveying. These hydrographic surveys are of use to engineers in planning port work, such as wharves, slips, and the like; channel improvements; jetties and other controlling works; submarine cables; and, in fact, all engineering operations in or around the water.

CONTROL SURVEYS FOR INTERIOR AREAS

There are two main divisions of control surveying—triangulation and leveling. Triangulation consists of the determination of the relative positions on the earth's surface of a series of points distributed throughout some extensive area. The project on which the Coast and Geodetic Survey is at present engaged contemplates a network of first-order triangulation spread over the United States in such a manner that, in general, no point shall be more than about 50 miles from a triangulation station. The areas included within these first-order arcs will then be subdivided by work of second-order accuracy, such that no point shall be more than about 25 miles from a station. At the present rate of progress, this work will be completed in some 12 or 13 years. The triangulation methods in use by the Survey were

McComb-Romberg Tilt Compensation Seismometer
Developed by H. E. McComb, of the Survey, Using the Tilt Compensation of Arnold Romberg, University of Texas

described in Civil Engineering for December 1930.

Precise leveling starts at the plane of mean sea level, as determined by the tidal work of the Survey at most of the principal ports on our coasts. It is spreading a network of level lines, following the railroads and highways over all parts of the country, with permanent bench marks at an average distance apart of about 2 miles along each line. When the work is completed in general no point will be more than about 25 miles from a bench mark whose elevation above mean sea level is accurately known. As in the case of triangulation, some 12 or 13 years work is required to complete the project.

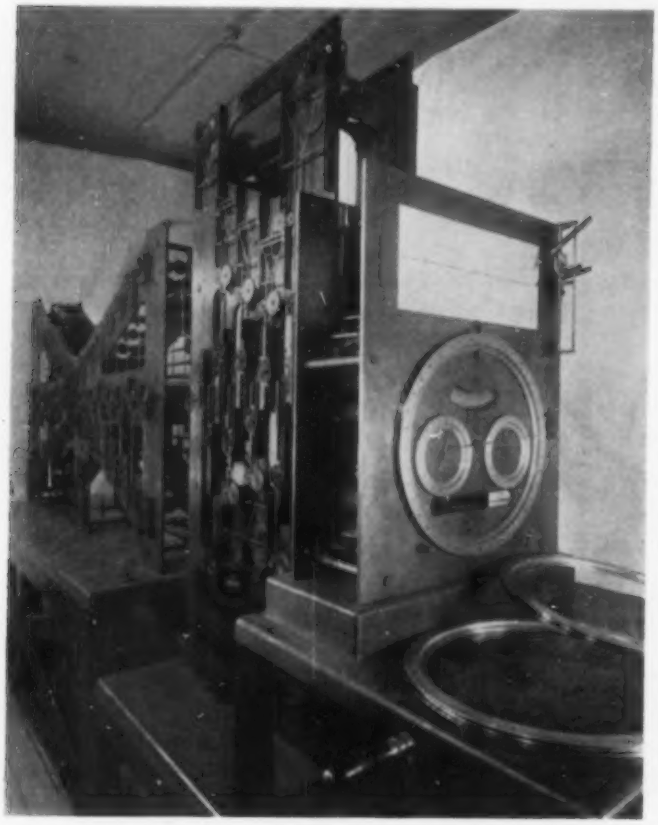
It is expected that all of the political boundaries of the country will eventually be tied into the triangulation system, and that spherical or plane coordinates will be assigned to each of these boundary monuments. When this has been done, the position of any monument can be accurately recovered if the monument should be destroyed, and there will never be any difficulty in recovering or relocating boundary corners.

TIDES AND CURRENTS MAPPED

Tidal datum planes for such phases of the tide as mean low water, mean sea level, mean high water, highest and lowest tides, have been determined at many places on the open coasts and tributary tidal waters of the United States and its possessions. The elevations of these datums are given by reference to fixed bench marks described in publications which are designed to cover each of the states fronting tidal waters.

Tide Tables, issued annually, give the predicted times and heights of the tide for each day of the following year

at the more important ports of the world. *Tide Tables, United States and Foreign Ports,* give the daily predictions at 92 of the most important ports covering the entire maritime world. In addition, tidal constants and differences are given for some 3,500 other places,



COAST AND GEODETIC SURVEY TIDE PREDICTOR
Sums the Effects of 37 Component Tides

which enable the engineer to determine, in advance, the time and height of the tide at practically all places of the maritime world.

While issued primarily for the use of the navigator, these tables furnish valuable information to the engineer engaged in harbor improvement or marine construction of whatever kind. The tide predictor, an instrument devised by the Survey, sums up the effects of 37 component tides and indicates the times and heights of high and low water.

To furnish information relative to the currents throughout the various waterways of the United States, the Survey annually issues current tables which give the times of slack and of strength, and also the velocities of the current for the following year.

To furnish comprehensive pictures of the current regimes in the various important harbors, the Survey is issuing a series of *Tidal Current Charts.* On 12 charts bound into a single pamphlet, they portray for each hour of the tide the velocity and direction of the current throughout the entire waterway. To the engineer interested in the sewage disposal of cities on tidal waters, or in harbor improvement, these charts furnish basic information which enables him to base his operations on definite quantitative data. At the present time, such charts have been issued for New York Harbor, Boston Harbor, and San Francisco Bay. Others will be issued as rapidly as possible.

In the early days of this country, land surveys by magnetic methods were included under engineering and, although this is no longer the case, it is still necessary to use magnetic methods to clear up many questions in regard to boundaries, even in cases where the present records are based on more precise methods. The Survey can furnish values of the magnetic variation applicable to any date within the past 50 years, which are generally correct to the nearest minute. Values applicable to earlier dates become progressively less accurate.

The information that has been compiled by the Survey has been used by geophysical prospectors using magnetic methods in increasing our knowledge of the available natural resources, especially oil and minerals, of the country.

STUDY OF SEISMOLOGY UNDERWAY

Only during the past six years has the Survey been charged with work in the field of seismology, and for three of those years no appropriation was made for carrying on the work. In spite of that handicap, a great deal has been accomplished, chiefly in laying the foundation for future activity rather than in accumulating the data which the engineer so urgently needs.

Many engineers believe, and the Coast and Geodetic Survey agrees, that additional fundamental investigations and data are needed before the engineer, in his design of structures, can take adequate account of earthquake stresses. This problem has been recognized by the American Society of Civil Engineers. A voluminous report has been made by a committee of the Society on the effect of earthquakes on structures, but it has not yet been printed.

This subject has been brought to the attention of the administration at Washington, and the budget for the fiscal year 1932 provides funds to enable the Coast and Geodetic Survey to begin this study. Progress has been made in the development of the necessary instruments and the work will start actively as soon as the necessary funds are provided by Congress.

AIRWAY MAPS AVAILABLE

The need of the aviator for flight maps is similar to, and eventually will be as important as, that of the mariner for nautical charts. In recognition of this need, when Congress passed the Air Commerce Act of 1926, it charged the Department of Commerce with the production of such maps, and the function was delegated to the Coast and Geodetic Survey.

Obviously, the characteristics of such a map must be based on the use to be made of it. The speed of the plane requires that it shall be on a small scale, so that a sheet of moderate size will cover a large extent of ground. Drafting must be simple and bold so that it can be read at a glance by the pilot. Under this program, the first work undertaken by the Survey was the production of maps of the improved airways. These maps cover strips of territory 80 miles wide, extending from one important airport to another. Under this pro-

gram, the Survey has extended the mapping of airways to cover the entire United States, divided for convenience into 92 parts.

ENGINEERS CAN BENEFIT

Our methods are constantly being improved so that unit costs today are as low as those of any similar agency. To aid in accomplishing these various purposes the Survey publishes a series of manuals covering all branches of its work. They not only prescribe the standards of accuracy to which the work must conform, but also give the methods for attaining those standards at minimum cost. I believe that the members of the American Society of Civil Engineers do not habitually engage in work similar to ours, but occasionally they are called upon to do so. Hereafter, when those calls come, I hope they will let us help them.

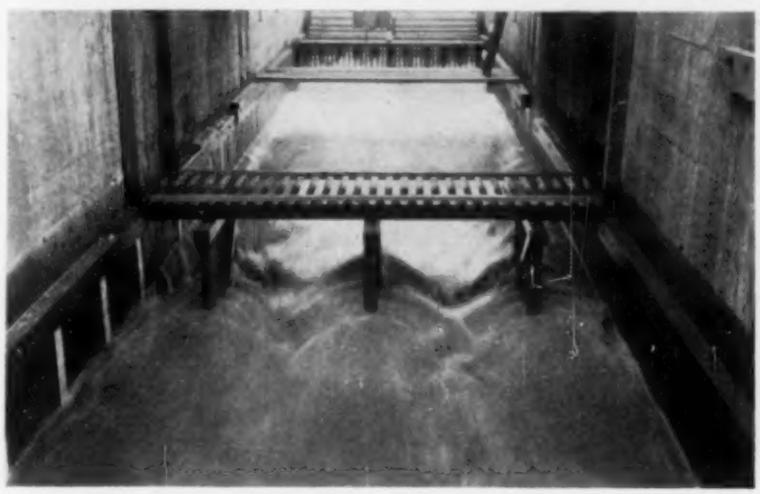
The Division of Agricultural Engineering

By S. H. McCrory

Member American Society of Civil Engineers
Chief, Division of Agricultural Engineering
Bureau of Public Roads, U.S. Department of Agriculture

THE application of engineering to agriculture is the province of the Division of Agricultural Engineering of the Bureau of Public Roads, U.S. Department of Agriculture. It is the one division in the Bureau of Public Roads that does not work with highways. Originally organized as Irrigation Investigations, the work has been carried on continuously since 1899.

The first chief of the organization was Elwood Mead, M. Am. Soc. C.E., who held that position until 1907, when the work was divided. Irrigation Investigation was placed under the direction of Samuel Fortier, and Drainage Investigations under the late C. G. Elliott, both Members Am. Soc. C.E. Later, about 1913, authority was granted for studies relating to farm machinery, farm structures, and farm water supply and sanitation, to be conducted by the Office of Farm Management. On July 1, 1921, the present Division of Agricultural Engineering was formed by consolidating the work of the three groups.



Determining the Effect of Bridge Bents on the Flow of Water
One-Quarter Scale Model, University of Iowa Hydraulic Laboratory

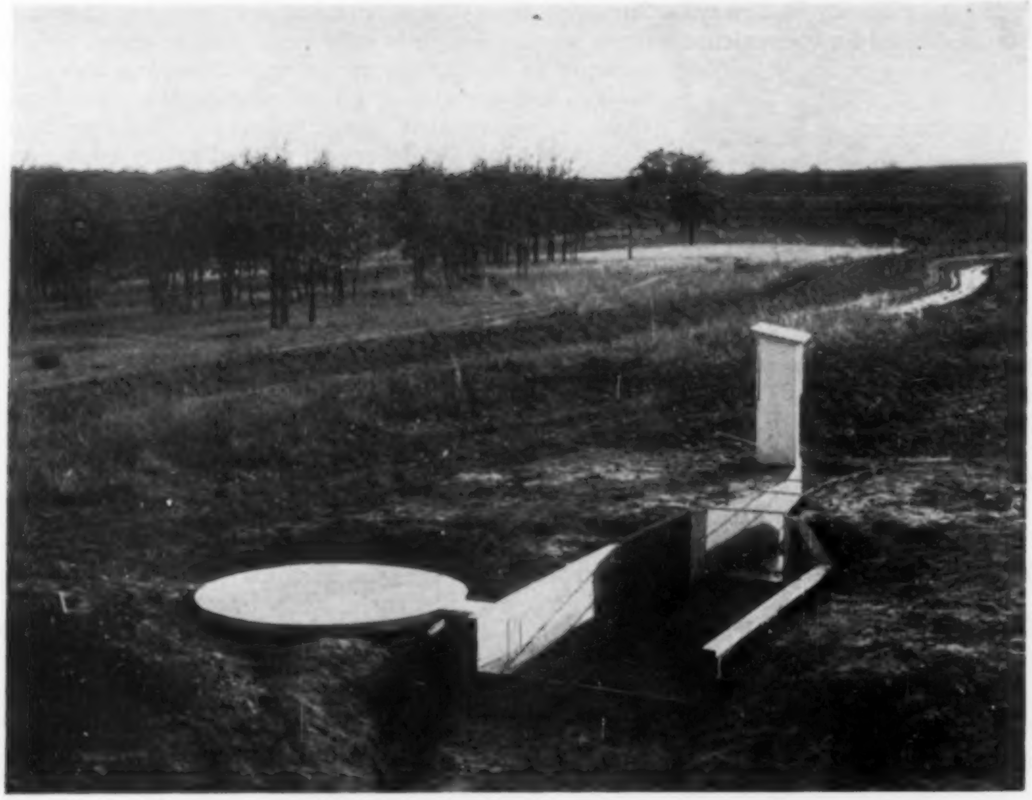
INVESTIGATIONS RELATING TO IRRIGATION

At the time the work in irrigation was started, little information was available in regard to the duty of water or the irrigation water requirements of crops. Investigations along this line have been carried on continuously since that time. They deal with the total seasonal requirements, seasonal distribution, evaporation, transpiration, surface waste, deep percolation, efficiency of application, and the most profitable use of irrigation water. These studies have been conducted throughout the semi-arid and arid regions and have yielded basic information for designing engineering works such as reservoirs, dams, canals, and laterals. From these data it is possible to determine the amount of water required to irrigate a given area or, conversely, the amount of land that can be irrigated with a given water supply.

Recently, in cooperation with the California State Department of Public Works and the University of California, we have been carrying on an intensive study regarding the consumptive use of water in California. In these studies, all the water that is applied in a given region is completely accounted for, and the amounts lost by evaporation, transpiration, deep percolation, and run-off are accurately determined.

The physical laws governing the flow of water in irrigation channels early engaged the attention of the division. An extended series of observations have been made and reported upon that pertain to the flow of water in irrigation canals, concrete pipe, steel pipe, and wood-stave pipe. The different factors affecting the flow in these structures, such as roughness, degree of curvature, and dimensions of cross section, have been evaluated, thus giving basic data for selecting and designing structures of this type.

Erosion and silt problems connected with irrigation water supply, including the quantity of silt by volume and weight, and the sizes of particles carried in suspension and as bed loads, have been investigated. These studies have been made in Arizona, California, New Mexico, and Texas; and basic data have been developed for estimating the effective life of reservoirs and the amount of silting to be expected and provided for in de-



WOODEN PARSHALL MEASURING FLUME
Measuring Run-off and Silt from Terraced Farm Land

surfaces, will be submitted for publication in the near future.

Machinery and implements used in constructing and maintaining irrigation and drainage canals, and in diking and otherwise preparing land for irrigation, have been and are being studied for the purpose of improving methods and of determining the costs of construction and upkeep.

Prior to 1902, there had been many attempts to reclaim lands which under irrigation had become seeped and alkaline. There had been many failures and few successes. Engineers of the division developed a technic of draining irrigated land which has been widely adopted not only in this country but abroad. Basic information has been developed and reported upon regarding the location, spacing, and depths of drains, the amount of water drained, the suitability of materials for use, and the appurtenances and methods of maintenance.

signing artificial channels and storage basins for irrigation waters.

In investigating the problems involved in pumping for irrigation and in the drainage of irrigated lands, special attention has been given to the installation, operation, and maintenance of equipment; to unit costs of pumping; and to the suitability, efficiency, and durability of different types of wells for irrigation and for the drainage of irrigated lands that have become waterlogged and alkaline. The operation of irrigation systems has been studied intensively, with particular attention to the various items of expense involved, including length of periods during which delivery of water is to be made, continuity of delivery, and rotations employed, with a view to obtaining basic information for determining the best methods of operating and financing.

Problems connected with maintenance of irrigation systems such as materials, methods, and costs involved in cleaning canals, lining canals, making repairs and replacements for irrigation structures, and repairing breaks in canals—all these have been investigated. Much study has been devoted to structures and appliances for use in connection with irrigation work such as diversion dams, reservoirs, syphons, gates, turnouts, and pipe—both to those generally used and those designed to meet special conditions.

In estimating losses of irrigation water, the questions of storage, conveyance, and application, as well as of the amounts lost by evaporation from reservoirs and from soils, have been studied. A comprehensive report on the results of more than ten years of work by engineers of the division, on evaporation losses from water

Irrigation organizations, such as irrigation districts, mutual irrigation companies, and commercial irrigation companies, have been studied and information in regard to the purposes, character, general utility, and methods of financing such enterprises has been secured. Recommendations have been made as to the types of organization best suited to specific enterprises. Considerable attention has been given to the problems involved in reorganizing a number of small districts into one large district, in order that available water may be used efficiently and the costs of operation and maintenance reduced.

DRAINAGE STUDIES

Recently, in cooperation with the University of Iowa, a laboratory investigation has been made of the flow of water through pile trestles and of the flow of flood water over railway and highway embankments. It is hoped that the data from these tests will be of much service to engineers and make possible more accurate estimates of flood flows when actual measurements of the discharge are not available.

When the low lands along the lower Atlantic and Gulf coasts are reclaimed and made available for agriculture one of the most important problems which must be considered is that of providing protection from storm tides caused by tropical hurricanes. Engineers of the division have secured detailed information in regard to

tides and their relation to the paths and intensities of these storms.

In many sections of the United States, streams during flood periods bring down large loads of silt, sand, and gravel, which are deposited where they leave the hills and enter the bottom lands. The problem of providing basins which will permit the waters of a stream debouching from the hills to be desilted and then picked up again by a channel below is one that has engaged the attention of the division. The division has also given much attention to the problems involved in the assessment of the benefits in drainage districts and to the provisions of state drainage laws governing the construction and operation of drainage improvements.

Reclaiming a Gulley by Small Pole Dams
The Odd-time Work of a Farmer Adds to His Cultivable Acres

In the Middle West, extensive use has been made of drain tile ranging in diameter from 12 to 54 in. and made of either clay or concrete. In certain regions the soil and ground water are charged with various minerals, mainly in the form of sulfates, which attack concrete. Somewhat similar difficulties occur in peat soil, although the causes are not clearly understood. While they are not completed, these investigations have already developed the fact that the cements made at different plants show widely different degrees of resistance when exposed to waters containing sulfates in considerable amounts.

SOIL EROSION INVESTIGATIONS

The problem of retarding the rate at which the fertile top soil is eroded from cultivated land is perhaps one of the most important that now faces agriculture. In 1913, we began an investigation of the engineering phases of the prevention of erosion and, in cooperation with the Bureau of Chemistry and Soils, we have recently established seven soil-erosion experiment farms where investigations are being conducted to determine the best methods of preventing, or at least of minimizing, erosion.

An indication of the magnitude of this problem is furnished by the results from an erosion survey that was made on the farm on which the division is working, near Guthrie, Okla. The best evidence available indicates that a depth of from 12 to 36 in. of soil has been eroded from the cultivated lands on this farm since cultivation began in the nineties. By the use of terraces, which are simply low earth embankments to carry the water from the field gradually, it is possible to reduce greatly the rate at which the top soil is eroded. Where gullies have formed, it is possible by the use of soil-saving dams, which can easily be constructed of brush, cornstalks or other easily obtained material, to check their progress and gradually fill them. Two years ago there were on the Guthrie farm, many gullies over which tractors could not be operated. By the use of soil-saving dams most of these have been eliminated and practically the entire area can be cultivated without difficulty. By the use of terraces on the fields, erosion has been very largely prevented. The best available information indicates that, during 1929, about two and one-half million acres were terraced in order to stop erosion.

ALL REPORTS ARE AVAILABLE

Much of our work has been published as bulletins of the Department of Agriculture. There have been issued, dealing with irrigation work, 96 technical publications, 33 farmers' bulletins or popular presentations, and 46 publications of miscellaneous character. Regarding drainage, there have been 33 technical bulletins, 9 farmers' bulletins, and 29 miscellaneous publications. On soil erosion, there has been one technical publication, and two farmer's bulletins. Much of the cooperative work has been reported in the publications of the state agricultural experiment stations, in the reports of state engineers, or in the technical press.

In the library of the Department of Agriculture is a large collection of material pertaining to irrigation, drainage, and the control of erosion. It is particularly rich in material relating to the work of the Agricultural Experiment Stations.

A Summary of the Present State of Prequalification

By C. J. Tilden

Member American Society of Civil Engineers
Strathcona Professor of Engineering Mechanics, Yale University

The subject of preliminary qualification of contractors, before they are allowed to submit bids, was chosen by the Highway Division of the Society as the chief topic for discussion at its meetings during the year 1930. A meeting of the Division was held at Sacramento, Calif., in April 1930, in connection with the regular quarterly meeting of the Society and another in connection with the meeting in St. Louis, Mo., in October 1930. The presentation of a number of papers on this subject was followed by oral discussion. In this paper, presented before the Highway Division of the Society at the Annual Meeting held in New York, January 22, 1931, Professor Tilden summarizes the more important points brought out at the two meetings.

At the Sacramento Meeting of the Society, a symposium on the prequalification of contractors, consisting of three papers with discussions, was presented. Both papers and discussions have been summarized in detail in Proceedings for August 1930, pp. 1245 to 1255.

In the opening paper, C. H. Purcell, Assoc. M. Am. Soc. C.E., of the California Division of Highways, defined prequalification as "the determination of responsibility before plans and proposals are issued for bidding." This determination is based on: (1) the contractor's previous experience; (2) the kind and condition of his equipment; (3) his record on previous work of similar character; (4) his financial condition; and (5) his character and general reputation. The many advantages resulting from limiting bidding to firms or individuals that submit satisfactory credentials along these lines were pointed out. In working out the principles of prequalification in California, the Highway Division has had the cooperation of the Associated General Contractors and also of the surety companies.

Six objections to prequalification which have been advanced were cited by Mr. Purcell. These include the claims that competition is restricted, that small firms are barred from bidding, that a certified check is sufficient evidence of competency, and that the questionnaire which must be answered is an unwarranted intrusion into private affairs. The author stated his belief that none of these objections is valid, and that prequalification will improve relations between the state and the contractor, and should result in a higher quality of service to the public without increased cost.

Legal Aspects Considered

A paper on the legal aspects of prequalification was presented by L. I. Hewes, M. Am. Soc. C.E., Deputy Chief Engineer of the U.S. Bureau of Public Roads. He stated that "authority to withhold the bidder's sheet from a contractor to whom award would not be recommended has never been questioned. Authority to require qualification statement in the form of the Joint Conference Questionnaire has also never been questioned." As practiced in certain states, the results of prequalification have so far been favorable.

In addition to California and South Carolina, which have recently passed specific laws for prequalification, Georgia, Missouri, and Tennessee are enforcing the system by administrative procedure. In Wisconsin it has been the practice since 1925, and in Iowa since 1927. Kentucky, South Dakota, and Kansas also require it.

On the other hand, proposed legislation for prequalification in Oregon failed in 1929. Dr. Hewes reviewed at length the causes for the failure, the chief of these being, perhaps, a provision in the bill to the effect that if a prospective bidder takes an appeal (from disqualification), no bids shall be opened or made public until this appeal has been determined. The award of important contracts might, under such a provision, be held up for three weeks. Mention was also made of the Governor of Pennsylvania's veto of prequalification legislation in 1929, on the ground that it placed unlimited discretion in one city official without opportunity for redress on the part of the disqualified bidder. The Philadelphia City Ordinance providing for the prequalification of bidders on city work was also discussed. In a suit brought by a bidder, the court decided that the ordinance was illegal, but on appeal the judgment of this court was set aside. However, the Supreme Court of Pennsylvania reversed this second decision and upheld the position of the appellant.

The Contractor's Standpoint

Prequalification was then discussed from the standpoint of the contractor by Walter Wilkinson, President of the California Branch, Associated General Contractors of America, who stated that responsible firms are hoping that the public may soon come to differentiate between classes of contractors and give up the "cheap-price method" of construction, with its attendant serious evils. He defined a responsible contractor as an experienced and competent man, who enters into his agreement with the expectation of abiding by the plans and specifications. Too often these considerations are neglected, the only two qualifications required being the lowest bid and a satisfactory surety bond.

It was pointed out that the system has been making progress throughout the country and seems to be here to stay. The Affiliated Bureau of the Associated General Contractors of America, organized in 1924, took the initiative in showing the advantages of prequalification, and the Surety Division of this bureau has supported prequalification legislation, having recently incorporated a Bureau of Contract Information, with headquarters in

Washington, to cooperate with those who are responsible in the award of construction contracts. This is a non-profit making, fact-finding organization, which is now engaged in investigating the performance record, reputation, and work on hand of every general contractor in the United States.

In opening the general discussion, Charles H. Stevens, M. Am. Soc. C.E., Engineer of Design of the Department of City Transit, Philadelphia, spoke of the peculiar situation in which public officials found themselves as a result of the Supreme Court decision on prequalification previously described by Dr. Hewes. This decision seemed to suggest the desirability of a Board of Review, composed of persons in no way connected with the department advertising for bids, in order to assure the bidders a better chance of unbiased consideration. This, in Mr. Stevens' opinion, would mean giving up a duty and responsibility that the city engineers would be loath to relinquish. Furthermore, such a board would not be in the public interest, for the engineers within the department are certainly best fitted to handle that phase of the work.

WHY CONTRACTORS FAIL

At the St. Louis Meeting of the Society on October 2, 1930, the symposium on prequalification was continued, four papers being presented. The first was by Robert B. Brooks, M. Am. Soc. C.E., Director of Streets and Sewers, City of St. Louis, who cited the large number of disastrous failures that occur on contracts in the United States and cost the public millions of dollars. A large surety company has classified the causes of its losses as follows: inadequate financial ability, 50 per cent; incompetency, 25 per cent; dishonesty, 15 per cent; miscellaneous—such as unavoidable difficulties, 10 per cent.

From time studies undertaken to determine the reason for unsatisfactory progress on Federal aid projects, the U.S. Bureau of Public Roads finds poor management, rating 52.7 per cent, the first cause; with bad weather conditions, rating 26.4 per cent, second on the list. Inadequate financial ability, construction difficulties, and minor causes follow in order.

The Bureau of Municipal Research of Philadelphia was quoted as being in favor of prequalification and Philadelphia's recent history with the system was related. A new prequalification ordinance, which became effective September 5, 1930, after being passed by the City Council, was written to include the provisions which the State Supreme Court held essential when it declared the first prequalification ordinance unconstitutional. In closing his paper, Mr. Brooks expressed the belief that there is a remarkable unanimity of opinion among responsible officials in favor of prequalification, because it is believed that it will reduce the high cost of incompetency and improve the quality of work.

In the second paper of the symposium, Alan Jay Parrish, of Paris, Ill., drew attention to the fact that prequalification has been general in the better class of private work, although it is only recently that it has come into use on public projects. The most outstanding example of public use is in the U.S. Bureau of Public Roads where, according to Thomas H. MacDonald, chief of the bureau, the experience has been eminently satisfactory. The American Association of State Highway Officials has voted overwhelmingly in favor of the principle and, by October 1930, twelve states were operating on this principle, either by specific statute or under the broad powers granted them under the law to select the lowest responsible bidder. These states were California, Connecticut, Georgia, Iowa, Kansas, Minnesota, Missouri, North Dakota, South Carolina, South Dakota, Tennessee, and Wisconsin. In addition, the system has been used in many municipalities.

"High-pressure selling," not only of equipment but of surety and contract bonds, is blamed for the encouragement of irresponsible bidders. From the standpoint of the public, the surety bond is far from being a satisfactory guarantee of performance, and the awarding official is faced with a serious dilemma. Bids on public works are given wide newspaper publicity, and failure to make award to the lowest bidder is at once questioned. It is almost impossible to make the public understand the need for care and discretion in the matter of responsibility, so prequalification of contractors is the logical step.

Although the standard questionnaires furnished a thorough method of investigating bidders, it was found that proper checking up of these questionnaires often required more time than could be given after bids were opened. This situation, Mr. Parrish pointed out, has led to the qualification of bidders before bids are taken, rather than after. Under this system, each bidder is required to submit in advance a sworn statement as to his experience, equipment, finances, and contracts on hand, and the awarding agency checks the truth of the information submitted. The remainder of Mr. Parrish's paper, in the form of a legal brief, cites the advantages of prequalification under ten headings, and then answers the objections which have been raised.

A brief history of prequalification was outlined by Ward P. Christie, Assoc. M. Am. Soc. C.E., Engineer for the Associated General Contractors of America. He stated that the movement began in 1924 in Detroit at a meeting of a joint committee of the Associated General Contractors of America and the American Association of State Highway Officials.

ATTEMPTS TO DEFEAT INVESTIGATION

Once a low bidder is identified, there are anywhere from a dozen to fifty agencies that attempt to defeat an investigation, Mr. Christie stated. The scramble for this man's business starts at once. Even the banker is willing to take a chance on him, if he has secured a substantial contract. It was pointed out that "prequalification is a job, but it isn't one-half the job that it is to get the truth after bids are opened." It was made clear by Mr. Christie that the large body of responsible contractors in the country are strongly in favor of a systematic and clearly worked out scheme of prequalification.

The final paper of the session was presented by W. W. Zass, M. Am. Soc. C.E., of the State Highway Department of Arkansas, who called attention to the fact that, in awarding contracts on a competitive basis, these three conditions may prevail: non-qualification, which allows bidding without restriction, the award going to the low bidder; postqualification, in which the award goes to the low bidder only when he is judged to be properly quali-

fied; and prequalification, or limiting bidding to those in a predetermined group. Non-qualification provides for competition without prejudice, but may increase the difficulty of obtaining first-quality work. Postqualification permits the exercise of some judgment and discretion, and may therefore eliminate some delays and losses resulting from incompetent contractors. Prequalification provides the advantages of postqualification with but few of its disadvantages.

DISCUSSION OF PAPERS

In opening the discussion of papers, S. A. Greeley, M. Am. Soc. C.E., of Chicago, asked if there are specific yardsticks by which to judge the qualifications of contractors in advance of bidding and if account is taken of the character of the work in setting up these yardsticks. Mr. Parrish replied that the responsible surety companies required liquid assets, varying from 40 per cent on the smaller contracts down to 15 per cent on large ones, assuming, of course, that the contractor owns his equipment, which is not to be considered a part of his liquid assets.

Expressing the belief that there is little doubt as to the wisdom of prequalification, Mr. Crosby, of California, nevertheless called attention to the importance of preventing the qualifying authority falling into unscrupulous hands. There must be limits to the rigidity of such qualification, for if it is made too severe, new men will be prevented from coming into the field, and as existing firms disappear there will be none to fill their places.

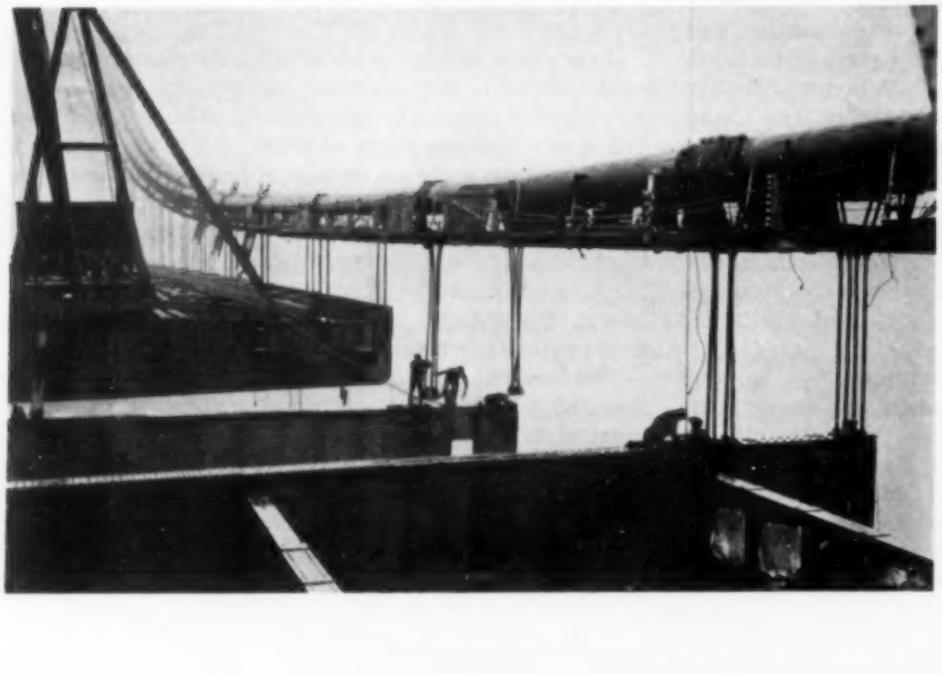
That the surety bond is still a potent factor in the construction industry and will continue to be so was the opinion expressed by Mr. Veatch, a practicing engineer of Kansas City. He criticized the looseness of some of the corporations doing bonding business and suggested the possible desirability of qualifying surety companies.

Conditions in Philadelphia were cited by C. E. Myers, M. Am. Soc. C.E., chairman of the meeting and Director of the Department of City Transit, Philadelphia. He stated that in Philadelphia the city official awarding a contract never knows who the bonding company is; it may be any one of a number of listed companies. For contracts of five hundred thousand and up, the city requires that a bidder must have 10 per cent of his bid in cash in a bank, and his monthly statements for a year past must average this amount. He must also show 25 per cent of his bid in quick liquid assets other than real estate. Conditions are less severe for the man who has done work of exactly the same character on as large a contract.

After W. A. Heimbuecher, M. Am. Soc. C.E., of St. Louis, had corroborated Mr. Veatch's remarks, Mr. Christie expressed himself as impressed by the failure of the discussion to mention character. In the mind of the banker experienced in credit matters and responsibility, the question of character is uppermost. If a man with character is put on a job some of the other qualifications can be waived. It was further suggested by Mr. Christie that contractors on public works be required to register with an authorized registration board that would require submission of credentials regarding such factors as financial standing, previous experience, and equipment.

A procedure, amounting practically to prequalification, was cited by J. E. Root, M. Am. Soc. C.E., who had used the method successfully in connection with some large contracts—five hundred thousand up to three million dollars. The bidder was asked to fill out the Associated General Contractors Association questionnaire and submit it with his proposal. Also, Mr. Root mentioned the fact that, on work for the Cincinnati Union Terminal, bidding is by invitation—that is, on a strictly prequalification basis.

In concluding the discussion, E. C. L. Wagner, M. Am. Soc. C.E., Executive Secretary of the Associated General Contractors of Missouri, stated his belief that there is no yardstick so good as past experience. He also expressed the hope that prequalification will capitalize past experience and make it profitable.



HUDSON RIVER BRIDGE AT FORT LEE

Connecting Center Floor Beam in Hanger Sockets

The Hudson River Bridge, the largest suspension bridge in the world, is being built across the Hudson River between Fort Washington, N.Y., and Fort Lee, N.J., by the Port of New York Authority. During the Annual Meeting it was the privilege of an interested group of members of the Society to view the progress made on this record-breaking structure. In this photograph, taken December 26, 1930, the detail of connecting the center floor beams into the sockets of the hanger is shown. On page 56 of the October issue, and on page 112 of the November issue of CIVIL ENGINEERING, will be found interesting illustrations of construction details used on this bridge.

More Proof That City Planning Pays

The Development of L'Enfant's Plan for Washington, D.C.

By U. S. Grant, 3d

Associate Member American Society of Civil Engineers
Lieutenant-Colonel, Corps of Engineers
Director of Public Buildings and Parks of the National Capital

Our national capital is the country's outstanding laboratory of city planning, in which have been tested by a century and a half of use the principles laid down by Major L'Enfant. As Colonel Grant emphasizes, practically every variation from the L'Enfant plan has resulted in some detriment to the beauty or usefulness of the area set aside for the city of Washington. All the municipal affairs of that city of half a million people are guided, and all its taxes appropriated, by the national Congress, in which its population has no representation. It is therefore necessary that public opinion throughout the Nation should impress members of Congress with the fact that city planning pays. The paper by Colonel Grant, here abstracted, was presented before the City Planning Division on January 22, 1931, at the Society's Annual Meeting.

Aside from the interest all patriotic citizens must necessarily take in the development of their nation's capital, the plan of the City of Washington and the various events that have marked its evolution have a special appeal for city planners and for those members of other professions whose work requires consideration of the many elements entering into city development. For here we have a city which did not simply grow in response to the forces of selfish interests and the demand for the highest immediate profit. The founders saw to it that the new Federal city, provided for by Article I, Section 8, of the Constitution, had a plan and, although this plan was disregarded at times and suffered neglect through considerable periods, there have always been those who have demanded a return to its fundamental principles and their application to the additional territory over which the city inevitably spread.

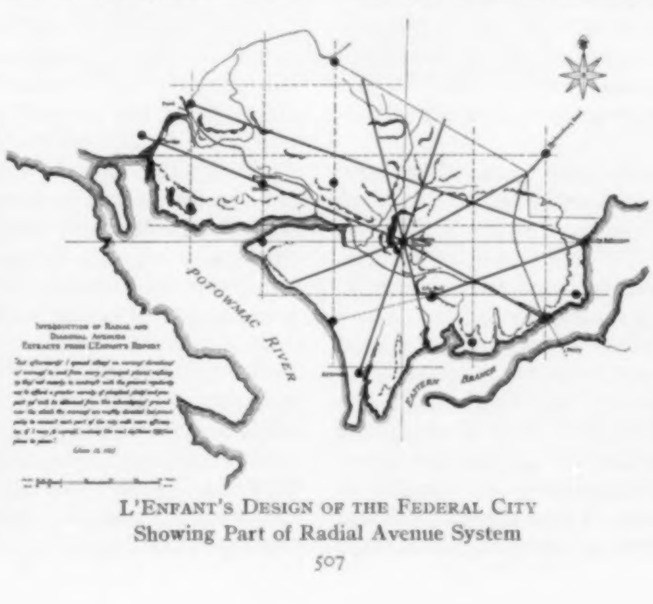
Thus the national capital has, since its foundation in 1791, been a laboratory in which the problems of city planning have been experimented with for nearly a century and a half. Here the theory and practice of city planning have been subjected to the test of actual experience and here, if there be any truth in our claims for the advantages of intelligent city planning, we should find the evidence to confirm that truth beyond a reasonable doubt.

Major L'Enfant's Plan Dated 1791

Immediately on being authorized, by the act of June 16, 1790, to select the site for the new Federal city and to proceed with laying it out and with the construction of public buildings, President Washington, with that rare wisdom which had won for him in such an unexampled degree the confidence of his compatriots, proceeded to find an expert city planner to make the plan. For this duty he selected Maj. Charles Pierre L'Enfant, a French engineer who had served with distinction during the American Revolution and had decided to cast his lot with the new nation he had helped to achieve independence. Apparently on the recommendation of Thomas Jefferson, Secretary of State in Washington's cabinet, Maj. Andrew Ellicott, another engineer officer and Surveyor General of the United States, was appointed surveyor for the new capital.

With characteristic energy, Major L'Enfant set about his new task and, in the incredibly short time of 20 days, he had a preliminary report and outline plan ready to present. He worked on the perfection of this plan as rapidly as the survey of the territory covered by it progressed and submitted his final plan and report to Washington at Philadelphia on August 27, 1791.

One of the original owners of land in the area selected for the city, Daniel Carroll, had started a handsome residence which was found to be located in the middle of one of Major L'Enfant's main avenues (since named New Jersey Avenue) south of the site chosen for the Capitol. The Major insisted that construction should be stopped immediately and that the work already done should be demolished. Since Mr. Carroll did not comply with this demand, the fiery Frenchman gathered together some workmen and saw to the job of demolition himself.



L'Enfant's Design of the Federal City
Showing Part of Radial Avenue System

The law of 1790 provided for three commissioners to have charge of the work on the Federal city under the direction of the President, but Major L'Enfant never fully acknowledged their authority and persistently reported directly to his chief, General Washington. It was perhaps not unnatural that the three commissioners appointed by the President should take advantage of the complaint of Mr. Carroll to make a case against

the Major. With evident true regret, President Washington finally dismissed him on their recommendation. But Major L'Enfant had completed his plan, and the city was laid out and the new public buildings were put up

TRAFFIC CONGESTION AT FOOT OF CAPITOL HILL, 1865

n substantial conformity with it—it is L'Enfant's plan.

UNIQUE FEATURES OF PLAN

The two most unique characteristics of his plan were its grand scale and the fact that it was laid out so as to utilize to the fullest extent the natural topography. He first selected certain prominent points as suitable sites for public or semi-public buildings and institutions. The one to which he attached greatest importance was that for the Capitol, or "the houses of Congress" in his terminology, centrally located as was desired by Washington.

Of this site L'Enfant says, "After much. . .search for an eligible situation. . .I could discover no one so advantageously to greet the congressional building as is that on the west end of Jenkins Heights, which stands as a pedestal waiting for a monument."

The site of next importance was that for the "Presidential Palace," a hill about a mile and a half to the northwest of the Capitol, having access to the city street system to the north almost on grade, but looking down a gentle slope to the south and then over the estuary of the Tiber and the Potomac River to Alexandria.

Along the line drawn westward through the site of the Capitol and that drawn southward from the proposed "President's Palace," Major L'Enfant planned broad park areas to contain the necessary public buildings and other public or semi-public institutions. At the intersection of these two lines he suggested an equestrian statue of Washington.

Thus it was proposed that the major axes of the new city should be two great parks meeting at a central point marked by a monument to the founder of the city, instead of having the city built about two commercial streets. Provision was made for a main commercial street in the avenue leading diagonally to the White House, since called Pennsylvania Avenue after the state in which Congress had sat for so many years.

Through the various sites selected, north and south and east and west, Major L'Enfant drew lines as the thoroughfares or major streets of his rectangular street system. Between these thoroughfares, and parallel to them, he located minor streets. From the Capitol and the President's house, he drew a series of radial lines like the spokes of a wheel and, in addition, joined by diagonals some of the major sites selected. He had in mind the utility of these avenues as super-highway direct connections between his principal points, as well as the value in a capital of the vistas that might be produced by streets converging on important monumental buildings.

His reports to Washington are interesting reading and worthy of study. There is certainly conclusive evidence that he did not attempt to fit some preconceived or copied plan to the ground, but built up his own plan on the basis of the topography and natural features, with a view to utilizing them to the fullest extent, while at the same time providing a development adequate to the capital of a nation large and important beyond what could then be foreseen.

WIDE STREETS A GREAT ASSET

His principal streets and avenues were planned with from 90 to 160 ft. between building lines, a much greater width than could be used advantageously for many years, and greater than the city in its infancy could afford to pave and maintain. And yet, his foresight and imagination in thus planning on a large scale have saved the city great amounts of money, since the streets, first developed over only a small part of the right-of-way, can now be widened at no more expense than the cost of additional pavement and the setting back of the curbs, where other cities are compelled to pay from $2,000,000 to $12,000,000 a mile for street widening in their central sections. Here advance city planning certainly has paid.

One of the results of the diagonal avenues was to create multiple street intersections at many points throughout the city. These were treated in the form of squares by L'Enfant, and many have since been developed as circles. Either treatment permits the gyratory traffic required nowadays for congested intersections of this sort. The National Capital Park and Planning Commission is now attempting a scientific study of these squares and circles at multiple street intersections, hoping that the experience of Washington may be of use in the future to other cities as well as to itself.

ARCHITECTURAL DEVELOPMENT REGULATED

As evidence of President Washington's foresight and wisdom, it is especially interesting that his contract with the original owners of the land in the area to be occupied by the new city included an agreement on their part to accept the President's prescription "for regulating the materials and manner of the buildings and improvements generally in the said city, or in particular streets or parts thereof for convenience, safety, and order." Thus he foresaw the need for some architectural control in such a city, a right which was suspended by President Monroe in 1822, and has had to be reasserted within the last year by the Federal Government in order to protect the new public building program against injury by private developments on adjoining property.

Of course, the L'Enfant plan, although it only covered the flat and gently sloping part of the District of Columbia, was on a scale far exceeding what could be usefully developed for about three-quarters of a century. Con-

siderable criticism and ridicule of it was, therefore, to be expected in the interim, but today we are grateful to Major L'Enfant for his foresight.

It was also natural that many things should be done which were inconsistent with the plan, although in general it was adhered to. For instance, the new Treasury Building was so located by President Jackson that, when it was finally developed and the south wing added, this was interposed between the White House and the Capitol, thus closing one of the important vistas provided by the L'Enfant plan. The Washington Monument itself, when started in 1848, was not located exactly at the intersection of the two major axes of the city, but was placed on available dry land about 123 ft. to the south and 375 ft. to the east of the site L'Enfant had indicated.

West End of Mall Completed—Plan of 1901
Lincoln Memorial and Arlington Memorial Bridge

Washington Monument Today

Perhaps the most serious departure from the L'Enfant plan was the failure to canalize Tiber Creek along the south side of B Street and reclaim the tidal flats of its broad estuary as a part of the central park system. This failure prevented the residential development of the peninsula south of the Mall, and left the estuary of the Tiber as an objectionable barrier to communication between the south end of the city and its center. Consequently, undesirable residences gathered on the north bank of the Tiber, as they do along the edges of cities, and this locality, which should have been along a great central park, gained a very unsavory reputation and the nickname of "Murder Bay." The unbalancing of the city by intensive residential development to the northwest was undoubtedly partly due, therefore, to this failure to carry out an important element of the original plan.

RAILROADS COME IN

The introduction of railroads about the middle of the century brought in a new element and, as their importance and growth could not be foreseen, it was perhaps not surprising that the Baltimore and Ohio tracks were allowed to be laid in the immediate vicinity of Capitol Hill, and the Pennsylvania Railroad was permitted to build its tracks across the Mall with a station in the Mall itself.

At the end of the Civil War the population of about 60,000 nearly filled the area covered by the original plan of Major L'Enfant, but very few municipal improvements had been made. The inhabitants were still dependent upon local springs for their water supply; there was no general system of sewage disposal; only very few streets were lighted, and those only with oil lamps; the broad streets and avenues were mostly unpaved and in many cases ungraded; and finally the parks, for which ample areas had been reserved in the beginning, were unimproved and neglected. Contemporaneous verbal accounts and pictures all confirm this.

Doubtless the many soldiers, politicians, and business men who necessarily passed through Washington during and immediately after the Civil War spread the news of the condition of the national capital and helped to popularize the idea that the Nation at large should see to it that it was built in a worthy manner. The first step was to turn over to the Chief of Engineers, in 1867, the custody and care of the public buildings and grounds, followed by the city parks in 1898, since which time their improvement and development have advanced as rapidly as appropriations have permitted. This removal of the parks from the jurisdiction of the municipal authorities was attended with the same success as in other cities, and these special ornaments of the capital now receive their proper share of attention.

MUNICIPAL IMPROVEMENTS PROVE BENEFICIAL

Becoming especially interested in the development of the capital, President Grant was successful in obtaining legislation in 1871 to establish a territorial government. The first territorial governor, who remained in office but a short time, was succeeded by the Commissioner of Public Works, Alexander H. Shepherd. In only a couple of years Mr. Shepherd accomplished a Herculean task—grading and paving went on apace; a general sewerage disposal system was inaugurated; the old Tiber Creek was inclosed in a

brick sewer; the water supply conduit tapped for immediate distribution; 3,000 gas street lamps installed; and a Park Commission set up which planted some 60,000 trees along the streets, thus laying the foundation of the present tree growth (now about 115,000), which

MULTIPLE STREET INTERSECTION, SCOTT CIRCLE
Results of Tree Planting Apparent

to a great extent gives Washington its unique appearance.

But all this work cost money, and Governor Shepherd's assumed obligations frightened the conservative citizens and efforts were made to stop him. This agitation finally ended with the act of June 11, 1878, by which the Territorial Government was superseded by the present commission of three. An interesting fact is that, however unpopular the Shepherd government made itself by its aggressive activity and rapid expenditure of funds, the work was well done and well worth while. The addition of $8,000,000 to the funded debt and the assumption of not more than $10,000,000 in less formal obligations produced municipal improvements which increased the assessed values 65 per cent in five years, in spite of the panic of 1873 and the consequent depression, and made possible an increase of 120 per cent in the population between 1870 and 1890.

This increase in population immediately after the Civil War resulted in the building up, without adequate thought and without effort to conform to the principles of L'Enfant, a number of subdivisions outside the limits of his plan. The evil effects of this were soon recognized and legislation in 1893, modified in 1898, started the extension of the street plan and set up a Highway Commission for the purpose.

ADOPTION OF NEW PROJECTS

Some important park projects were adopted, notably the purchase of the land for Rock Creek Park and for the National Zoological Park and the filling in of the Potomac tidal flats to make nearly 1,000 acres of the Potomac Park system. But the adoption of only the items of major importance could be obtained individually in this way, and the Highway Commission, being concerned with streets, did not plan for parks.

It remained for Col. T. A. Bingham, Officer in Charge of Public Buildings and Grounds, to get Major L'Enfant's plan out of the files and show not only how no provision was being made for parks in the new parts of the city, but also how some of L'Enfant's major projects had been entirely lost sight of and were about to become forever impracticable. Finally Elihu Root, then Secretary of War, President Roosevelt, and Senator McMillan, Chairman of the Senate Library Committee, became converts and secured authority for the appointment of a special commission of experts to study the problem.

It is only necessary to name the members of this commission, which has since usually been known as the McMillan Commission, or the Commission of 1901, to indicate the quality of its work: Daniel H. Burnham, Frederick Law Olmsted, Jr., Charles F. McKim, and Augustus St. Gaudens. It reaffirmed the soundness of the L'Enfant plan and recommended its extension on a scale more adequate to the greater capital of a greater country and in a manner inspired by its spirit. Although the commission's plan was never adopted as a whole, it was so convincing and sound that it commanded respect and inspired the execution of its major projects.

Of these, the more important adopted before 1926 were removal of the Pennsylvania Railroad station from the Mall and the construction of a new union station through which, like a great portal to the city, the traveler enters the city by what will be the enlarged Capitol Plaza and in sight of the Capitol itself; the Lincoln Memorial and reflecting pool; the Arlington Memorial Bridge; the Grant and Meade Memorials, as main features of the great Union Plaza at the foot of the Capitol; the Rock Creek and Potomac Parkway, joining these two major park systems; the Anacostia park development; and some parts of the Fort Drive.

In 1910 a new commission was established by law, the Commission of Fine Arts, to pass on monuments, fountains, and memorials in Washington and otherwise advise the Government on matters of taste and esthetics. This commission, not unnaturally, became the guardian of the plan of 1901, and has not only helped materially in getting various projects adopted, but has also deserved the gratitude of the Nation for the bad things it has prevented.

ZONING LAW ADOPTED

Congress is always ready to pass progressive legislation for the District of Columbia when the local authorities and public opinion agree as to the advisability of the measure. It is not surprising, therefore, that a law limiting the height of buildings to the width of the street was adopted in 1910, or that a zoning law was passed and a zoning commission set up as early as 1920. It appears possible from existing conditions to avoid the necessity for subways, double-deck streets, and other very expensive traffic relief measures.

PART OF PUBLIC BUILDING PROGRAM
Department of Commerce Building

In Washington there is another reason for preventing high buildings. Great stress was laid by Major L'Enfant, President Washington, and all those who have followed in their footsteps, upon the location of the Capitol on a hill in the center of, and overlooking the city. If build-

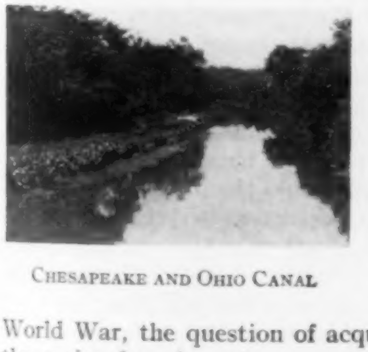
ings in the business district were allowed to be built to a height exceeding that now set by the Zoning Commission, even to the maximum height of 130 ft. prescribed by law, their roofs would be from 6 to 8 ft. above the roof of the Capitol building and the effect on it would necessarily be injurious.

Zoning is, however, only a preventative against harmful or improper growth. The highway plan was adopted in the days of animal transportation and required quite thorough revision in the areas outside of L'Enfant's plan to meet the needs of, and take advantage of the change to automobile transportation and the latest developments in city planning. It had never been reconciled with the plan of 1901, and many features of the latter itself had become impracticable because of expensive building developments which were inconsistent with it. The rapid increase in population since the World War started new subdivisions outside the limits of the District of Columbia, requiring planning and control to fit them into a proper regional plan.

Recognition of these needs, which the American Society of Civil Engineers was among the first to appreciate, brought about the formation of the National Capital Park Commission in 1924, and its evolution into a National Capital Park and Planning Commission in 1926. To supplement its efforts for a sound regional plan, the states of Virginia and Maryland have set up commissions to cooperate with it.

REGIONAL PARK SYSTEM DEVELOPED

Since its formation in 1926, the Park and Planning Commission has, in addition to taking care of the problems constantly arising, prepared a regional plan which was presented at the meeting of the American Society of Landscape Architects about a year ago. Of course, some parts of this regional plan have been developed in more detail than others, and the parts outside the District of Columbia are necessarily still open to modification in order to conform with special local needs of the suburban settlements as rapidly as they become known. However, a very carefully designed system of regional parks has already been given legislative approval, and the commission's plans for radial highways, cross-connecting highways, airports, sewerage and drainage, and water supply have been generally accepted as guides in designing projects of the kind.



CHESAPEAKE AND OHIO CANAL

Because of the rapid suburban growth and the extent of building operations since the World War, the question of acquiring lands needed for the regional park system was most urgent, and plans for this system therefore received special attention and first priority. A series of maps were prepared which began, of course, with one showing the areas having grades of 15 per cent or more in their natural condition, that is, lands especially favorable for park use because of their picturesqueness and generally wooded character, and, on the other hand, especially unfavorable for building development so that their use for parks would make the least deduction from ultimate taxable values.

PLANNING THE PARK SYSTEM

On maps of the same scale there were then indicated

REMAINS OF "PATTOMACK" CANAL LOCKS
Built by George Washington

points of interest which it would be desirable to incorporate in the park system—points of geological, ornithological, and biological interest; points connected with the history and life of the aborigines before and immediately after the advent of the white man; points of historic interest, such as the old battlefield of Bladensburg and the old dueling ground; points of architectural interest, such as Washington's old home at Mount Vernon, the Octagon House, once the home of President Madison, and the house used by L'Enfant and Washington as an office in planning and laying out the new Federal city; and points of engineering interest. Among these last are the aqueduct bridge, built from 1857 to 1864 and for many years the longest single masonry arch in the world; the old foundry in Foundry Branch Valley; and foremost of all, the remains of the old Potomac Canal and its locks near Great Falls, which was organized by George Washington and built to a considerable extent under his personal supervision—probably the only remains of any engineering work that we are sure was done by him. Of course, due regard for primary park values and for the cost of the land has prevented inclusion in the proposed park system of any but the most important of these points and the areas containing the greatest concentration of them.

Within the District of Columbia, the park system as proposed includes neighborhood recreation centers for all kinds of sports in residential districts, approximately a mile apart, with playgrounds for small children at distances of a little over a quarter of a mile; a circumferential parkway including and joining the remains of the old Civil War forts, which, because of their commanding positions, combines special scenic and historical interest with provision for the necessary cross connections between arterial highways in the outlying residential areas; and, together with appropriate extension of the small city parks planned by L'Enfant, a special park-plaza development at each entrance of the main radial highway into the national capital.

Finally, the regional plans contemplate the extension of certain park projects, like Rock Creek Park, into Maryland where they will add materially to residential values. Up the Anacostia and northeast branch valleys there is a great opportunity for a parkway similar to the Bronx Parkway all the way to Baltimore. The execution of these plans for both city and regional parks

GREAT FALLS OF THE POTOMAC
Included in Public Park System

seems to have been reasonably well assured by the passage last year of the Cramton Act. When they are completed, the park system will provide, assuming reasonable development of local parks and playgrounds in the suburban areas of Maryland and Virginia, approximately one acre for every 185 inhabitants anticipated under existing zoning restrictions. This figure is of interest as showing that the plans are conservative as compared with the park developments of some of our less congested cities, and have been kept well under the optimum of one acre to every 100 inhabitants advocated by park experts.

SAVING CONSTRUCTION COSTS

Within the District of Columbia, one of the most urgent problems is the replanning of the street layout in areas not yet built up. Changes saving the taxpayers over $500,000 have already been made. It is estimated that application of the same methods to all the remaining undeveloped areas would save about $3,500,000 in ultimate initial cost of street construction, and $325,000 in annual cost of maintenance and auxiliary municipal utilities. At least equal savings would accrue to the owners and developers of real estate. Here again city planning pays.

Unfortunately, under existing laws, the plan of a street cannot be changed, except by special act of Congress, when any part has been dedicated, so that additional legislation will be required in order to make possible those changes and savings, which, even though not great in individual cases, amount to much in the aggregate. Besides, as many of the changes are in the nature of a better adjustment of grades to the natural topography, they will enhance the value of residential neighborhoods by preserving their individuality and making available for their beautification large sums that would otherwise have to be spent on grading.

For traffic needs, the most important and expensive projects are for widening and straightening streets in the subdivisions outside the L'Enfant plan, and for carrying some major avenues through them. These subdivisions grew up without any official plan, and therefore in disregard of the original plan. A beginning has been made by the accomplishment of one such project, but because of limitations of the city budget, the work will necessarily take time.

RECENT TRAFFIC SURVEY MADE

A special study made under the auspices of the commission last spring by Dr. McClintock of the Erskine Institute, and partly paid for by voluntary contributions, showed the exceptionally intense automobilization of the population, one automobile to every 3.6 inhabitants, and resulted in some interesting data about the automobile parking problem. Any adequate solution of this problem requires such complete cooperation of private interests, municipal authorities, and Federal officials, that no practical results have yet been obtained beyond calling the evils of the existing conditions forcibly to the attention of all concerned.

The meager use made of mass transportation, as shown by this survey—26.1 per cent on street cars and 2.7 per cent in busses into and out of the congested business area of the city—has confirmed the need for improvement in these services recommended by the commission three years ago. The gradually diminishing returns of the street car companies are counted on to help force action in this regard.

Numerous other problems demand attention and are in course of being worked out. The absorbing and really inspiring element about being connected with city planning work in Washington is that the best development is still possible. No fatal mistakes have been made. There is an interested and sympathetic attitude in Congress, which is our only legislative authority, and acts really as our board of aldermen or city council, and the only serious resistance to overcome is from the small-town minds in official positions and from local selfish interests. In his letter to the American Society of Landscape Architects, read at its meeting on January 17, 1930, President Hoover said: "It is our national ambition to make a great effective city for the seat of our Government."

It is, therefore, necessary that we, who are engaged upon the work of making the capital the best expression of the art of city planning that America can produce, have the support and sympathetic understanding of civil engineers, and that they should see to it that their approval is understood and expressed by their representatives in the House and Senate.

Because of the professional standing of the members of this Society and because of the encouragement we have received in the past from the Society's spokesmen, I ask, with some confidence in the favorable reception of the request, that members undertake to lead public opinion in this direction wherever they may reside and help us to convince members of Congress that city planning not only adds to the attractiveness and comfort of a city, but that, on a practical cash basis, it pays. Certainly the experience of Washington proves this fact, if any proof were necessary.

Natural Gas for Steam Power

Fuel Oil, Coal, and Gas Evaluated

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With the high over-all efficiencies now obtained in steam turbine plants for the generation of electric power, this type of power generator unit has become a competitor of the hydro-electric station. More especially is this true in locations where natural gas from oil fields can be delivered cheaply as a boiler fuel. As Mr. Rhodes pointed out in his paper, presented on January 23, 1931, before the Power Division at the Annual Meeting of the Society, and here abstracted, natural gas as a boiler fuel has many advantages not readily apparent. A more complete knowledge of the factors surrounding its supply and use will often pay increased returns to gas pipe line and boiler plant owners and will result in community benefit by reducing the smoke nuisance.

NATURAL gas is the ideal fuel for steam boilers. It is generally so recognized because it is easy to burn at a uniformly high efficiency; it is smokeless and clean in the boiler room; it makes possible the operation of boilers at high capacity with small draft loss; and it results in remarkably low furnace maintenance. However, as a boiler fuel, natural gas is available only in certain sections of the country. In most cases there is no natural gas at all and in others it cannot be furnished at an economic price.

Near Monroe, La., is the Sterlington Power Station of the Louisiana Power and Light Company, which burns natural gas exclusively. The plant is located in the heart of the Monroe gas field and no provision whatever has been made for the use of any other fuel. Being so located, there are no transportation costs, and accordingly gas is sold at a low price and is available continuously. This plant is of recent construction and has carried loads upward of 100,000 kw. Its construction cost was unusually low, in large measure because of economies introduced through the use of natural gas as the sole fuel, it being one of the cheapest sources of power in America.

The Louisiana Steam Products, Inc., has recently constructed a 45,000-kw. plant to supply power to the utilities in the district surrounding Baton Rouge. It furnishes both power and steam to the Baton Rouge Refinery of the Standard Oil Company of Louisiana. Natural gas is its principal fuel but oil sludge and other refinery wastes are also consumed. The refinery itself, located approximately 180 miles by pipe line from the Monroe gas field, burns gas in the refining operations. The gas, which is sold at a correspondingly higher price than in the gas field, is continuously available except during emergencies and extreme domestic demand for gas. In the event that gas is not available, the power plant operates on the refinery products.

The natural gas-fired power plant of the New Orleans Public Service, Inc., in New Orleans, is of 135,000-kw. capacity, and is at the end of a pipe line approximately 275 miles long, extending from the Monroe gas field. This plant burns gas when, as, and if, available, but by far the greatest portion of the fuel consumed is natural gas. Either oil or pulverized coal may be used if it is necessary to discontinue the gas supply. The plant is operated at times partly on gas and partly on other fuels. Whenever there is an increase in other demands for natural gas in the territory served by the pipe line sufficient to overload the line, the power station changes one or more boilers from gas to other fuel on request of the load dispatcher of the pipe line and, when such outside demands for gas decrease, the boiler or boilers are again put back on natural gas.

In California there are two notable examples of gas-fired power boilers—the 85,000-kw. Seal Beach Plant of the Los Angeles Gas and Electric Company, and the 300,000-kw. Long Beach Plant of the Southern California Edison Company. These plants are operated under somewhat the same conditions as exist at New Orleans. Their economy is second to none.

There are numerous plants in the West and Middle West that operate on natural gas and, in most cases, provision is also made for oil or other fuel as an auxiliary or emergency supply.

Of course, in the aggregate, the capacity of power plants using natural gas as a fuel is small as compared with the total capacity of power plants in the United States. While the use of gas for power purposes is increasing, its increase will be defined by certain limitations to its value and availability.

Ideal as natural gas may be as a boiler fuel, its use is likely to develop only when it saves money for the power plant and makes money for the gas company. There is no simple rule-of-thumb method for determining either the value or the cost of natural gas in any particular case. All the circumstances surrounding each project must be taken into consideration and the ratio in value of natural gas to coal, for instance, under one set of conditions may be quite different from the ratio under another. Considerations other than thermal value alone must be taken into account.

FIELD AND TRANSPORTATION COSTS VARY

In some fields, temporary supplies of natural gas are obtainable at prices as low as 3 cents per thousand. More permanent supplies cost from 5 to 10 cents per thousand, and there is one field where the price of gas at the well is above 20 cents per thousand. Furthermore, the price of gas in any field almost universally increases as the field becomes depleted. This increase is due not only to the fact that it costs more to produce gas as the field pressure becomes lower, but to the fact that the demands on a field generally increase as the field grows older and there remains but little cheap competitive gas.

The cost of transporting gas is proportionate to the length of the pipe line, and is roughly proportionate to the inverse square root of the quantity of gas to be transported. For instance, doubling the length of a line doubles its cost but a line of double the capacity can be built for about 40 per cent increase in cost. The character of the country through which the line must be built is an important factor. Through relatively rough country, such as is encountered in the East, the cost of transporting gas may be twice that in the flat Middle West country.

It will appear, therefore, that there can be no generalization as to the price at which pipe line companies can be expected to sell gas for power plant use. Each project will determine conditions for itself, based upon the economic factors that have developed for that particular project.

The annual cost of owning and operating any given natural gas transportation system, exclusive of the cost of gas in the field, is practically a fixed annual expense, independent in large measure of the amount of gas that is transported over the system within the limits of its capacity. Fixed charges of interest, taxes, and depreciation, or the equivalent amortization of investment, constitute the largest part of the transportation cost. The expenses involved in patrolling and maintaining the gas system and in manning the pumping stations ready for service are practically fixed. There is a difference in cost in operating the stations at full load, for instance, as against half load or quarter load, but this difference represents generally only about one-sixth of one cent for each compressing station, per 1,000 cu. ft. of gas pumped.

The cost to the gas company, therefore, of serving any particular customer is an annual cost proportionate to the pipe line capacity required to serve that customer, plus the field cost of gas, plus a relatively small cost for pumping the gas through the line. The amount of profit that a gas company should earn is not a subject for discussion here, but certain factors should not be overlooked in considering the reasonableness of any profit, such as the possibility of gas fields being discovered closer to the market which would render obsolete, in a degree, the gas company's pipe line system, and the risk that the gas fields may become exhausted sooner than anticipated, necessitating an extension of the system to other fields, or, in remote contingencies, destroying the usefulness of the line.

It will be evident that a most important consideration affecting the price at which gas can be sold to any power plant is the relation of the average daily use of the gas to the pipe line capacity required to supply that power plant. If the load is steady night and day and uniform throughout the entire year, it is to be expected that the price at which gas can be sold will be lower than for a use which is heavy in winter and light in summer or which occurs during the daytime only.

POWER PLANTS USE OFF-PEAK GAS

Long pipe lines are generally built to supply the so-called higher uses of gas. Domestic use alone generally cannot justify a long pipe line. Uses other than domestic—such as in metallurgical processes in glass making, and in the ceramic industry—are generally most desirable for a pipe line. They are more nearly continuous than the ordinary power plant use in that they are carried on steadily night and day throughout the entire year, varying with business conditions, but commonly resulting in average use of gas over a period of years equal to about 70 per cent of the pipe line capacity required to supply these uses, and the gas has a value generally beyond its heat content alone. It has been found, therefore, that most natural-gas pipe-line systems depend for their principal business on uses of natural gas for puposes other than power plant fuel.

The power plant business, however, is a desirable business to the pipe line companies under certain conditions. Any pipe line supplying a domestic market inevitably suffers from extreme peaks in demand for gas in the coldest weather, which occurs only for a few days in the year. A power plant, therefore, which can shift to some other fuels on such days is a more desirable customer to the gas line than one which cannot so shift and would accordingly expect to receive some price benefit in utilizing off-peak gas.

There is no well established practice for determining the price at which off-peak natural gas can be sold for power plant use. There are, however, certain companies which sell the gas for such off-peak use at a price approximately midway between the field cost of gas and the price at which a firm, continuous supply of gas is sold to the metallurgical industry. For instance, in the case of a theoretical strictly modern line 500 miles long, through flat country, having a capacity of about 100,000,000 cu. ft. per day with a market sufficiently large to load the line and with a field cost of 5 cents per 1,000 cu. ft., it might be expected that the wholesale price of gas at the market to large consumers would be somewhat as follows:

Domestic gas at the city gate having an average annual use equal to about 35 per cent of the line capacity required..40 cents per million cu. ft.

Firm industrial gas to large metallurgical operations having an average use of about 70 per cent of the line capacity required ....22.5 cents per million cu. ft.

Seasonal power plant gas when pipe line capacity is available due to slack domestic demand...........14 cents per million cu. ft.

HEAT VALUE OF GAS AND OTHER FUELS COMPARED

When they first study the economic possibilities of natural gas as a power plant fuel, engineers are confronted with a factor unfavorable to that fuel, commonly called the "hydrogen loss." This amounts to 9 or 10 per cent with natural gas, depending upon method of determination. It is frequently exaggerated in importance, and comparisons of natural gas values have erroneously been made on the assumption that the hydrogen loss was a peculiarity of natural gas not shared by other fuels and that there were no other possible factors in combustion which could offset this loss. The hydrogen loss is shared by all fuels in the proportion that hydrogen enters into their composition, but there are other factors in combustion which usually more than offset the extra hydrogen loss of natural gas.

The heat value of fuels as customarily stated is the gross heat value as determined by a calorimeter. Any hydrogen contained in the fuel burns to water. In the calorimeter the products of combustion are cooled to

their initial temperature and the water resulting from the combustion of the hydrogen is condensed, giving up its latent heat. This latent heat amounts to approximately 1,000 B.t.u. per lb. of water of combustion or 9,000 B.t.u. per lb. of hydrogen burned. When a fuel is burned under a boiler, the water formed by the combustion of hydrogen goes up the stack as water vapor and accordingly carries with it as a loss the latent heat of vaporization. It also carries with it a further loss due to its sensible heat which is most conveniently considered as a separate loss.

Since fuels are so widely variant in their characteristics that generalizations can be only approximate, I will consider here only one typical natural gas, one typical fuel oil, and one typical coal. The typical natural gas is that found in the Monroe-Louisiana gas fields. It has a gross heat value of approximately 21,000 B.t.u. per lb. or 1,000 B.t.u. per cu. ft. The typical oil taken is an average oil having a heat value of 18,800 B.t.u. per lb. The typical coal taken is Alabama Big Seam coal having a gross heat value of 13,200 B.t.u. per lb. dry, and a net ash content of 12 per cent. The hydrogen loss per pound of these fuels is approximately 9,000 B.t.u. multiplied by the weight proportion of hydrogen. The approximate gross and net B.t.u. values of these fuels are as shown in Table I.

Table I. Gross and Net Heat Value of Typical Fuels

	Natural Gas	Fuel Oil	Alabama Coal
Gross B.t.u. per lb.	21,000	18,800	13,200
Per cent hydrogen	21.5	12.5	4.8
Hydrogen loss at 9,000 B.t.u. per lb.	1,935	1,125	432
Per cent	9.2	6.0	3.3
Net B.t.u. per lb	19,065	17,675	12,768

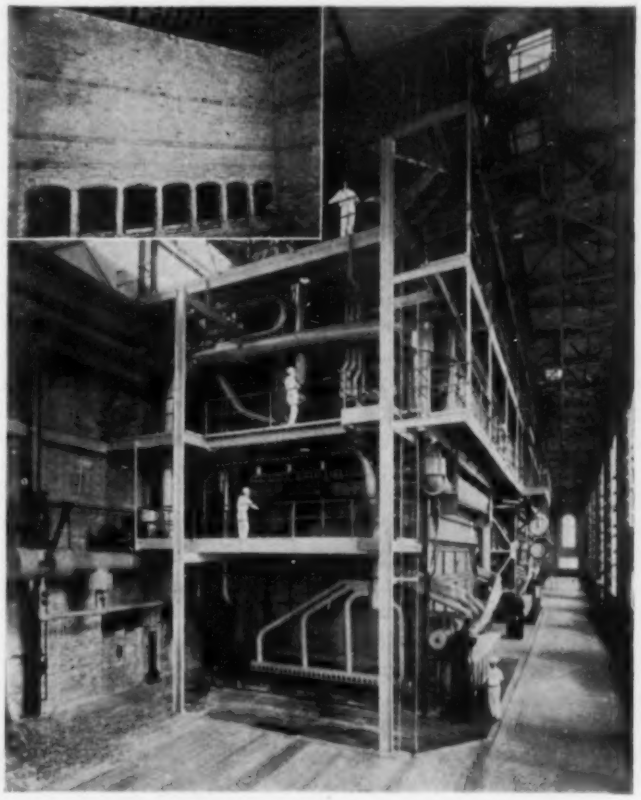
There is a further similar loss in the case of any solid fuel represented by the latent heat of vaporization of the moisture content of the fuel. This moisture may well be taken at 5 per cent, the loss, therefore, being approximately 50 B.t.u. per lb. of coal or approximately 0.4 per cent of the typical coal. This brings the total hydrogen and moisture loss of the typical coal to 3.7 per cent. The moisture in natural gas, if present at all, is already a vapor and in fuel oil is generally so small in amount that it is insignificant. Accordingly, the comparative latent heat losses of the three typical fuels are as follows:

Natural gas	9.2 per cent
Fuel oil	6.0 per cent
Alabama coal	3.7 per cent

The hydrogen loss detriment of natural gas is 3.2 per cent as compared with fuel oil and 5.5 per cent as compared with Alabama coal.

The other factors which usually offset the hydrogen detriment of natural gas and the entire range of losses and costs must be considered in making a proper valuation of gas as compared with the other fuels. It is rather difficult to set forth these various losses in a convenient form, particularly if complete refinement is necessary. A fairly close approximation is, however, attempted, since a proper appreciation of all the factors is necessary to arrive at any valuation of natural gas as a power plant fuel.

The latent heat losses to the stack are proportional to the hydrogen and to the moisture content of the fuel. An appreciation of the sensible heat losses in the flue gases is complicated in a considerable degree because the temperature of flue gases from any given boiler varies with the load on the boiler, with the fuel used, and with the method of operation. If fuels could be burned satisfactorily with the theoretical amount of air, it is probable that the flue-gas temperatures would be the same for all fuels at the same boiler output. However, the amounts of excess air required to burn the different fuels satisfactorily vary widely and it is the result of this variance, both direct and indirect, that gives great advantage to natural gas.



Sterlington Power Station, Boiler Room
Natural Gas Fuel Used—Note White Uniforms. Insert Shows Interior Condition of a Furnace Even After Long Periods of High Overload.

Low Combustion Temperature

In the case of natural gas, the amount of excess air ranges between $7^1/_2$ and 15 per cent. This low excess is possible, not only because the gas is easy to burn but because the temperatures in a natural gas furnace of reasonable design are so low that brickwork maintenance is at a minimum. The low combustion temperature is due in part to the hydrogen losses but probably in greater degree to the high specific heat of the water vapor of combustion, which also seems to be accompanied by a high rate of heat transfer to the heating surface of the boiler.

To burn oil in the ordinary large fire-brick lined furnace generally requires from 30 to 40 per cent excess air, and small furnaces require more. Oil can be burned in furnaces equipped with water walls, however, with prac-

tically the same amount of excess air as natural gas. The water walls protect the brickwork and keep the flame temperature within reasonable limits.

Pulverized coal, if burned in ordinary fire-brick lined furnaces, requires from 40 to 70 per cent excess air, depending on size, method of firing, and fuel preparation. In large water-wall furnaces 20 to 30 per cent excess air is sufficient on account of the reduction in flame temperature by the water walls. Lesser amounts of excess air, however, tend to result in incomplete combustion.

In stoker practice it is often necessary to use from 50 to 70 per cent excess air, although, with some large furnaces, as little as 35 per cent is possible. It is difficult to maintain a uniform fire throughout the firebed.

In the hand firing of coal, it is impracticable to maintain even as uniform a firebed as in stoker practice and accordingly 100 to 125 per cent excess air is about the best that can be expected.

Excess air influences the flue-gas losses in combustion in two ways: by increasing the weight of flue gas for a given amount of fuel; and by increasing the flue-gas temperatures above those which would obtain with lesser amounts of excess air and complete combustion.

With any of the typical fuels, the sensible heat flue-gas losses with the theoretically correct amount of air are equal approximately to 2.2 per cent of the heat value in the fuel per 100 deg. fahr. that the flue gases exceed in temperature the air in the boiler room. The heating of the theoretical air accounts for 1.9 per cent and the remainder may be attributed to heating the fuel itself. When excess air is supplied, each 100 per cent of excess air causes a further loss of 1.9 per cent of the total heat of the fuel per 100 deg. fahr. that the flue gases exceed in temperature the air in the boiler room.

NO ASH LOSS IN USE OF GAS

Ash losses are absent in the case of natural gas and practically absent in the case of fuel oil. Even with pulverized coal it is common to find that the ashes taken from the furnace contain as much as 10 per cent combustible material, and with stoker or hand firing sometimes 50 per cent.

The other losses in operating boilers, which on test reports are referred to as "unaccounted-for losses," are due in good boiler settings largely to radiation. They may be as low as 1 per cent in recent installations but commonly run from 3 to 5 per cent even in fairly large boilers. In small boilers these losses may be as high as 10 per cent, due in considerable measure to the relatively small amount of heat generated for the size of the furnace and also to the fact that small boilers are rarely as well maintained as small plants. A poor boiler setting will permit the infiltration of air and have practically the same effect on the efficiency of the plant as excess air. These losses are characteristic of the particular boiler setting rather than of the flue used. Wherever natural gas makes it possible to operate the boilers at higher overloads than is possible with coal, as in the case of hand firing, then natural gas will result in a reduction in the unaccounted-for loss through reducing the number of boilers necessary to keep in service to supply the load. In most boiler plants operating small boilers, the indirect saving on this account may well be from 2 to 3 per cent.

LOSSES AND BOILER EFFICIENCIES SUMMARIZED

It is well to have in mind certain typical boiler efficiencies that may be expected under average operating conditions with the typical fuels discussed, namely, natural gas, fuel oil, and Alabama coal. For this purpose, approximate figures are given based on the above factors, covering several different types of furnace ranging from the most efficient to the least, when operated at about 250 lb. pressure and at a high load factor, practically eliminating banked fires. These types are as follows.

1. Modern large boilers fully equipped with water walls, economizers, and air preheaters in which flue-gas temperatures as low as 300 deg. are frequently experienced, and in which the temperature differential due to excess air is probably one-half of that experienced in the ordinary plant. Such furnaces are commonly used for pulverized coal, oil, or natural gas, practically unchanged for the different fuels.
2. Large boilers with fire-brick lined furnaces such as are commonly used for stoker firing and for oil firing, and sometimes for pulverized coal firing in converted plants. In these furnaces it is necessary to use considerable amounts of excess air to keep furnace temperatures within safe operating range.
3. Hand-fired furnaces with good operation.

Table II is a summary of the basic heat loss factors, operating data, and heat losses for the different types of furnace, which form the basis for an approximation of the boiler efficiencies to be expected with the different typical fuels under consideration. Under test conditions lower losses are possible.

TABLE II. SUMMARY OF BASIC DATA AFFECTING HEAT LOSSES IN BOILERS BURNING TYPICAL FUELS

Loss Factors, Per Cent	Natural Gas 21,000 B.t.u. per Lb.	Fuel Oil 18,800 B.t.u. per Lb.	Alabama Coal 13,200 B.t.u. per Lb.: Pulverized	Alabama Coal 13,200 B.t.u. per Lb.: Mine Run
1. Stack Loss				
a) Latent heat	9.2	6.0	3.7	3.7
b) Sensible heat per 100 deg. fahr.				
(1) Consumed fuel	0.3	0.3	0.3	0.3
(2) Theoretical air	1.9	1.9	1.9	1.9
(3) 100% excess air	1.9	1.9	1.9	1.9
2. Ash Loss				
a) Sensible heat	—	—	0.3	0.3
b) Unburned carbon in refuse	—	—	$\frac{13.2 \times (\% \text{ carbon})}{100 - (\% \text{ carbon})}$	
Performance Factors				
3. Per Cent Excess Air				
Type 1 Boiler	7.5–15	7.5–15	20–30	35–50
Type 2 Boiler	7.5–15	30–40	40–55	40–55
Type 3 Boiler	10–20	50–60	—	100–125
4. Flue Gas Temperature, Deg. Fahr.				
Type 1 Boiler	308–315	308–315	320–330	335–350
Type 2 Boiler	565–580	610–630	630–660	630–660
Type 3 Boiler	570–590	650–670	—	650–675
5. Per Cent Carbon in Refuse				
Type 1 Boiler	—	—	8–12	25–35
Type 2 Boiler	—	—	8–12	25–35
Type 3 Boiler	—	—	—	35–45
6. Other Losses, Per Cent				
Type 1 Boiler	1–2	1–2	1–2	1–2
Type 2 Boiler	3–5	3–5	3–5	3–5
Type 3 Boiler	4–6	4–6	—	5–8

In Table III is given the corresponding boiler efficiencies to be expected with natural gas and other typical fuels under normal operating conditions.

FUEL STORAGE AND COST OF FIRING IMPORTANT

The cost of unloading and storing oil and coal and of preparing coal for combustion is as much a part of the cost of oil and coal as the price f.o.b. railroad siding. As a part of the storage cost should be considered any losses in heat value due to storage, and the interest on the fuel held in storage, not only for the average period that it is actually so held, but for an additional period of one month, because natural gas is generally billed on an average of one month after the time of its consumption. For purposes of comparison with natural gas, however, where natural gas is available only for part-time consumption, no fixed charges should be included on the plant and equipment for unloading, storing, and preparing the alternate fuel.

TABLE III. SUMMARY OF EXPECTED OPERATING EFFICIENCIES (IN PER CENT) IN BOILERS BURNING TYPICAL FUELS

	Natural Gas 21,000 B.t.u. per Lb.		Fuel Oil 18,800 B.t.u. per Lb.		Alabama Coal 13,200 B.t.u. per Lb.			
					Pulverized		Mine Run	
	High	Low	High	Low	High	Low	High	Low
Type 1 Boiler	85.0	83.5	88.2	86.7	88.2	85.8	83.9	79.0
Type 2 Boiler	76.9	73.9	77.0	73.3	76.2	71.0	71.9	65.7
Type 3 Boiler	75.6	72.1	72.7	69.0	—	—	61.3	50.9

The costs of unloading, storing, and atomizing fuel oil will generally range from 5 cents per barrel, in the case of very large plants, to 10 cents per barrel in the case of small plants. Such costs in stoker-fired plants will generally run to 25 cents per ton, and for hand-fired plants to 50 cents per ton. The cost of unloading, storing, and preparing coal in pulverized fuel plants will run from 50 cents per ton in very large plants to $1.00 per ton in small plants.

The cost of firing the different fuels is also as much a part of the cost as that of the fuel itself, but for the purposes of natural gas evaluation, only the savings in cost that can be achieved with natural gas need be considered. As compared with pulverized coal and oil, natural gas can show little, if any, saving in the firing costs. As compared with stoker operation, however, natural gas will show a saving of at least 10 cents per ton of coal. In the case of small hand-fired boiler plants, the savings in firing costs other than the cost of handling are small, because such plants ordinarily operate with about as small a force as could be considered safe for satisfactory operation.

The costs of maintaining furnaces fired with natural gas, oil, and coal are widely different. In burning oil and coal, an attempt is made to secure a proper balance between efficiency, as controlled by excess air and maintenance, which is rapidly increased if the excess air is kept too low. This is particularly true of oil and pulverized coal. Perhaps the best published data as to the relative boiler room maintenance when burning the different fuels is that published in the *Electrical World* of September 26, 1925, in an article by Vern E. Alden, entitled "Operating Performance of Steam Generating Stations." In it are given power costs in a large number of power stations of various sizes burning more than 10,000,000 tons of coal, 6,000,000 barrels of oil, and 9,000,000,000 cu. ft. of natural gas. The average boiler room maintenance cost computed from these data is as follows:

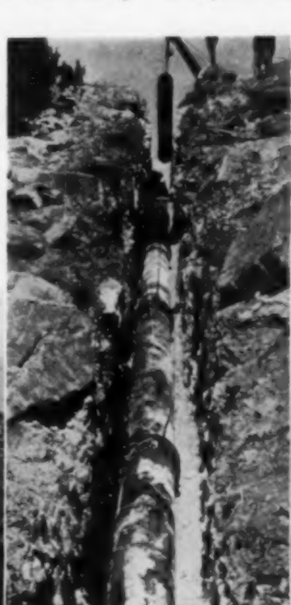
Coal-burning stations . . .	46.9 cents per ton
Oil-burning stations	7.1 cents per barrel
Gas-burning stations . . .	0.32 cent per million cu. ft.

These averages do not necessarily apply to any individual case but are reasonably applicable to the ordinary type of refractory furnace. Where water walls are used, as in the larger modern plants, there is little difference in maintenance to be expected with the different types of fuels.

GAS-FIRED BOILERS WITH SUPERHEATERS

In a plant where the superheaters are of the so-called "convection" type located well away from the furnace, natural gas generally results in a reduced superheat. This reduction generally does not exceed 25 per cent of the superheat or about 50 deg. in the steam temperature. In the ordinary power plant a pound of steam supplied to the turbines represents approximately 1,200 B.t.u. A 50-deg. reduction in superheat generally increases the steam consumption of the turbines by approximately 3.6 per cent, namely, about 1 per cent for each 14 deg. The reduced temperature of the steam, however, reduced the heat in the steam by approximately 25 B.t.u. per lb., which is 2.1 per cent. The net effect of the increased steam consumption of 3.6 per cent, and the reduced heat per pound of 2.1 per cent, is a net penalty of approximately 1.5 per cent against natural gas under such circumstances.

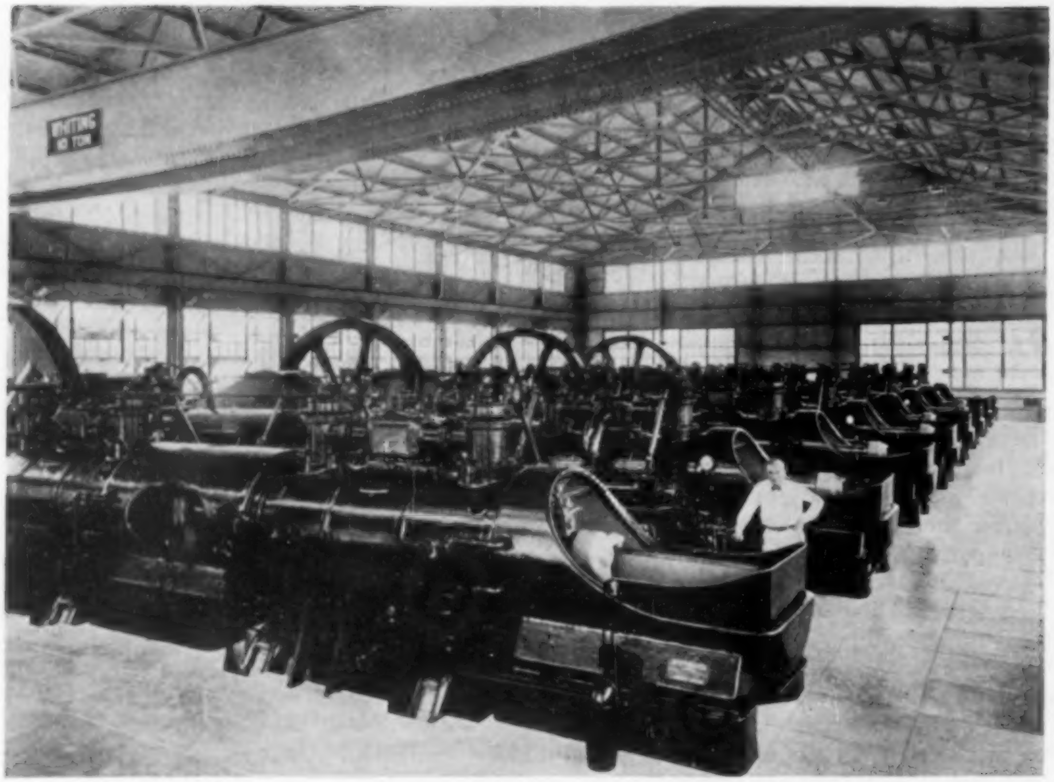
Construction in Louisiana



Tough Going in Colorado

Difficulties with Mud and Water

WHY NATURAL GAS LINES VARY IN COST



A TYPICAL PIPE-LINE COMPRESSING STATION

With radiant-type superheaters or superheaters located in close proximity to the furnace, no such reduction in superheat is experienced and in some instances natural gas has resulted in much greater superheat than anticipated.

FIXED CHARGES CONSIDERED

Fixed charges enter into the evaluation of natural gas in two way, first, charges on the cost of installing new fuel burning equipment in the boiler room and, second, charges on investment already made. Consideration should be given to the investment in natural gas burning equipment, which generally runs from $1.50 to $2.00 per developed horsepower. The fixed charges on this investment are quite unimportant. If natural gas is to be evaluated as against coal in a hand-fired plant which is proposed to be equipped with stokers, then it would be necessary to evaluate the gas on two bases, first, by neglecting charges on stoker equipment, using gas part of the year and hand-firing during peaks, and, second, by including the fixed charges on the cost of the stoker installation and taking into account stoker efficiencies which, in practice, are generally less than guarantees.

For the purpose of evaluating a seasonal supply of natural gas, fixed charges on fuel storage and burning equipment for the present fuels should not be taken into account because they will be unaffected in any way by the use of gas. If a continuous supply of gas is available, and its use is being considered either for a new plant or a plant which it is proposed to rehabilitate, then there should be credited to natural gas or charged to coal the fixed charges on the installation that is eliminated by the use of natural gas.

The value of the typical natural gas may be directly computed from the efficiencies given in Table III and from the prices of alternate typical fuels plus the unloading, storing, burning, and maintenance costs outlined above. It is quite as erroneous to neglect a lack of efficiency or the costs of burning the different fuels as it is to neglect the fuel prices themselves. It is found that, as compared with the typical fuel oil, the typical gas is worth from 15.8 cents to 18.5 cents per 1,000 cu. ft. and, as compared with the typical coal at $3.00 per ton, the typical gas is worth from 12.8 cents to 20.4 cents per million cu. ft., depending on the type of furnace and assuming a replacement of the present fuel.

CONCLUSIONS

It is at once apparent that there can be no simple rule-of-thumb method for evaluating natural gas. Its value differs with different types and sizes of plants as well as with the kind and delivered costs of other fuels. In any particular plant conditions may exist quite different from any of the conditions here assumed, and naturally, in such a plant, natural gas would have a value different from any of the values previously listed. However, application of the principles here outlined to the conditions existing in any particular plant will result in a generally close evaluation of natural gas as a fuel.

It is believed that natural gas can economically come into much greater use as a power station fuel when there is a full appreciation of all of the facts and factors surrounding its supply and use. Not all pipe line companies have an appreciation of the value of off-peak business at a reduced price. Sometimes political considerations make it impossible for pipe line companies to sell such off-peak gas. There are, however, some pipe lines that can be justified economically only by selling off-peak gas to power plants. Power plant operators often fail to appreciate, and are difficult to convince of, the values of natural gas other than those which are most apparent, and are frequently inclined to exaggerate the disadvantages of a seasonal source of natural gas. With the full development of the economic possibilities of power station fuel unrestricted by other considerations, some pipe line companies could materially increase their earning capacity, boiler plants could reduce their costs, and the community would benefit through reduction in the smoke nuisance.

Record Hydro-Electric Turbine Installed

Spier Falls Plant on the Hudson River Enlarged

By John P. Hogan

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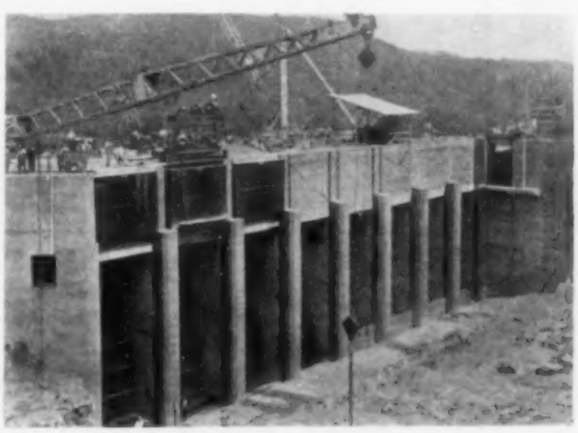
Completion of the Sacandaga Reservoir has so regulated the flow of the Hudson River as to permit the installation of power plants on the river with an ultimate capacity which may reach a million horsepower. In this abstract of Mr. Hogan's paper, read before the Power Division of the Society on January 22, 1931, at the Annual Meeting, is described the design and construction of a 57,000-hp. unit added to the Spier Falls plant. A required capacity of over 7,000 sec-ft. made the physical dimensions of this Francis turbine the largest yet built. Among a number of unusual details, the arrangements made to by-pass trash and ice are worth examining, as well as those made to keep the spillway gates free of ice. Model tests of the forebay resulted in an appreciable saving in cost of construction.

One of the earliest large hydro-electric developments in this country was the Spier Falls plant of the New York Power and Light Corporation on the Hudson River, at a point about 12 miles upstream from the City of Glens Falls. It was placed in operation in 1903. This plant originally consisted of a large gravity-type masonry dam; a side-hill forebay, with a masonry intake dam, designed for ten units, at right angles to the main dam; riveted steel-plate penstocks 12 ft. in diameter; and seven horizontal-shaft 40-cycle hydro-electric units of 5,000-hp. capacity each, installed in a power house designed for ten machines. In 1923, a 9,000-hp. 60-cycle vertical unit was added, using intake openings No. 8 and 9, which increased the capacity of the plant to practically 45,000 hp.

The completion of the Sacandaga Reservoir, which will store over 710,000 acre-ft. of water on the Sacandaga River, one of the main tributaries of the Hudson, will provide a minimum flow in the power stretch of the Hudson of 3,000 sec-ft. and a flow of 5,000 sec-ft. for 50 per cent of the time. This reservoir makes it possible to consider the eventual development of the entire Upper Hudson River for short-term peak power. The projected development of 12 consecutive plants below the reservoir makes provision for ultimate water capacities at each of the sites of between 10,000 and 22,000 sec-ft. This development will, of course, be progressive over a number of years and the ultimate capacity of all the plants may reach 1,000,000 hp.

PEAK CAPACITY DEVELOPMENT

The expectation of eventually developing the river exclusively for peak capacity makes it necessary to take into account at this time these ultimate high rates of water use. Such a consideration makes it appear expedient that all additions made in connection with the progressive scheme of developing the Hudson River should be planned with these volumes of water in mind. Added units, therefore, should be as large as is consistent with the present state of hydro-electric practice.



The New Intake and Gates, Upstream Face
Ice Sluice and Shelf on the Right

After extended study, it was decided to build at Spier Falls at this time an addition of one unit having a capacity of 7,200 sec-ft. under an 81-ft. head, and to make provision for the installation, in the near future, of a second unit of the same size. This large water-carrying capacity under a comparatively moderate head resulted in a wheel, the physical dimensions of which are somewhat larger than any attempted to date, but not enough larger than some recently installed, or contemplated for construction, to introduce any considerable element of risk on account of unusual size. Whether or not there will be larger wheels built is a question. It is possible to contemplate a reaction turbine with a capacity up to 10,000 sec-ft. but I doubt whether there is any great saving due exclusively to the concentration of water capacity to make that a controlling factor.

The problem at Spier Falls was complicated by the necessity of keeping the existing plant in continuous operation during the construction of the addition. However, two shut-downs were allowed during this period—one of two weeks and one of one month. It was necessary to coordinate building operations so as to bring these shut-downs at a time when the capacity of the existing plant could best be spared. The entire construction, from the day the work started to its completion, was done in one year.

GENERAL PLAN ADOPTED

As soon as the size of the additional unit was decided upon, studies and estimates were made of a number of possible designs. It was found that the one adopted was also the most economical. It consisted of the enlargement of the old forebay, placing of the new unit just downstream from the existing vertical unit, and excavating the bottom of the river so as to form an adequate tailrace to its point of junction with the head of the Sherman Island pond. The general lay-

out is given in Fig. 1, with the exception of the spillway portion of the dam, which extends to the north of the bulkhead section shown. The original extent of the forebay and the headworks, which were in line with the dam crest, are omitted. Maintenance of the original dam, which was and is in excellent condition, was also called for in the plan, which included the substitution of a new movable crest for the wooden flashboards heretofore used to create additional head and pondage.

OLD POWER HOUSE WITH NEW UNIT ON THE LEFT

Also included in the new work was the construction of an ice sluice to the east of the new intake and power house, the reconstruction of the county highway past the plant, and the building of new access roads to the intake and to the power house. There was, of course, a substantial addition to the electrical outdoor structures of the substation, the description of which is, however, not included here.

FOREBAY ENLARGMENT BASED ON MODEL TESTS

The original forebay, which was designed to take care of approximately 8,400 sec-ft., had to be widened and deepened to carry the ultimate capacity of approximately 18,000 sec-ft., so as to avoid exorbitant losses in the passage of water from the pond to the intake structure. The headworks offered such resistance to the flow of this large amount of water that the only economical solution was its complete removal. The cross section of the enlarged forebay was studied and laid out on the basis of an average velocity of 4 ft. per sec., this low velocity having been assumed on account of the unknown disturbing influences of expected eddies and cross currents created by drawing the water from the forebay through the side intake in varying amounts.

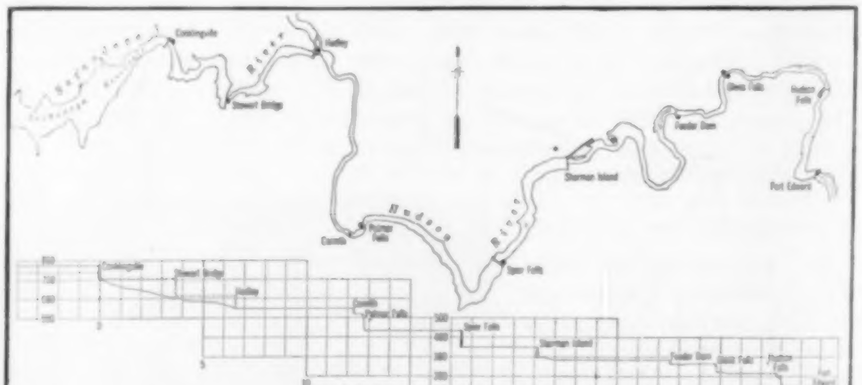
As the forebay is in a side hill excavation, it was obvious that any widening of it would be expensive and would be uneconomical unless resulting in a material reduction of head losses. It was therefore decided to build a model in which the water conditions could be simulated, the flow studied, and the losses determined. Such model tests were performed at the Alden Hydraulic Laboratories of the Worcester Polytechnic Institute, and from the data obtained the economical size of the forebay was established, the result indicating the possibility of saving a very substantial amount of excavation and, consequently, of expenditure. This saving is estimated to amount to as much as ten times the cost of the model tests.

BULKHEAD WALL NECESSARY

The north side of the forebay is bounded by the intake structure and the south side by the natural rock shore. On the east, however, it was necessary to build a substantial concrete bulkhead wall to retain the water of the forebay on one side and the embankment of the switch yard on the other. In this wall, near its junction with the east end of the new intake, an opening was left, equipped with a downward opening sliding gate 8 ft. wide and 14 ft. high, with its sill 3 ft. below low water elevation.

Through this opening ice and floating debris can be sluiced from the forebay into the ice chute, which discharges into the river below the power house. The opening at the sill was provided with an inward projecting concrete shelf to facilitate the sluicing of the ice. The advisability of constructing this shelf was also indicated by the model tests. In the accompanying illustration, the ice sluice opening and the shelf can be seen at the right. The ice chute is a concrete trough 6 ft. wide, carried under the power-house access road in a culvert. The bottom of the channel is armored with steel rails. Where the trough enters the culvert, a removable trash screen is provided for the collection of debris so that the operators can dispose of it by hauling away or burning instead of returning it to the river.

Excavation of the easterly part of the forebay, construction of the bulkhead wall, and of the new intake were done under the protection of a cofferdam built across the old forebay just east of No. 8 intake. This cofferdam was built on dry ground by closing the headworks gates



THE SPIER FALLS DEVELOPMENT

and draining the water from the forebay. After the cofferdam was completed the head gates were raised, the existing units having operated during the whole period of construction except when it was necessary to excavate in that portion of the forebay facing the old intake. After this excavation was completed, the old headworks was demolished.

INTAKE, TRANSITION, AND PENSTOCK DETAILS

Although the new intake and transitions are complete for both proposed additional units, only one penstock was constructed to supply the new unit. The new intake is contiguous with the old one, the eastern portion of which had to be demolished to make room for it. Its location is shown in Fig. 1, and the general design in Figs. 2 and 3. A view of the completed intake on the forebay side is also shown.

The new intake is a hollow dam of substantial height, and contains four openings for each unit, these openings being protected by trash racks and provided with electrically operated steel gates of the self-closing type generally known as "Broome" gates. When repairs to the racks or gates are needed, any opening can be closed at its upstream end by means of steel shutters operated by a traveling hoist. In a photograph three of these shutters are seen hanging near the top of the intake in three of the bays. When used, all three shutters are placed in the grooves of one opening, completely shutting off the water in that entrance. The trash racks are also seen, and their design is indicated in Fig. 2.

NOVEL METHOD OF CLEANING TRASH RACKS

It was thought that, due to the large size of the turbine, it would be sufficient to space the rack bars $5^1/_2$ in. from center to center. Because of the depth of the water and the consequent height of the trash racks, they are cleaned by a mechanical rake which travels on the top of the intake and discharges the trash into a trough from which it can be sluiced into the ice chute. Velocity through the racks varies between 3.1 and 3.6 ft. per sec. depending on the height of the water and load conditions. The "Broome" gates are 12 ft. wide and 17 ft. 6 in. high, and the velocity through the gate openings is between $7^1/_2$ and $8^1/_2$ ft. per sec. These dimensions were determined during the model tests already mentioned. These tests also proved very conclusively that, if the transition of the velocities to and from the gate openings is smooth, such velocities will not cause any appreciable loss of head.

Just behind the "Broome" gates every water passage is provided with a vent pipe 42 in. in diameter, located in the rear wall of the intake, to relieve surges in case of sudden closure or opening of the turbine or head gates. The water passages downstream of the head gates were gradually converged into a single circular conduit. This part of the structure was termed the transition of the intake. In it the velocity of the water gradually increases from about 8 ft. per sec. to about 13 ft. per sec.

The Reconstructed Spillway of the Spier Falls Dam
Tainter Gates and Wooden Flashboards Installed

The penstock starting at this point is 26 ft. in diameter and extends for a distance of about 40 ft. to its junction with the steel scroll case of the unit. The intake, transition, and penstock were constructed of concrete which had to be heavily reinforced on account of the very large loads on the various parts of these structures. In the design, consideration had to be given to the stability of the structure as a dam, to its strength under normal operating conditions, and to the stresses due to unbalanced loading of parts of the intake when the shutters are in use.

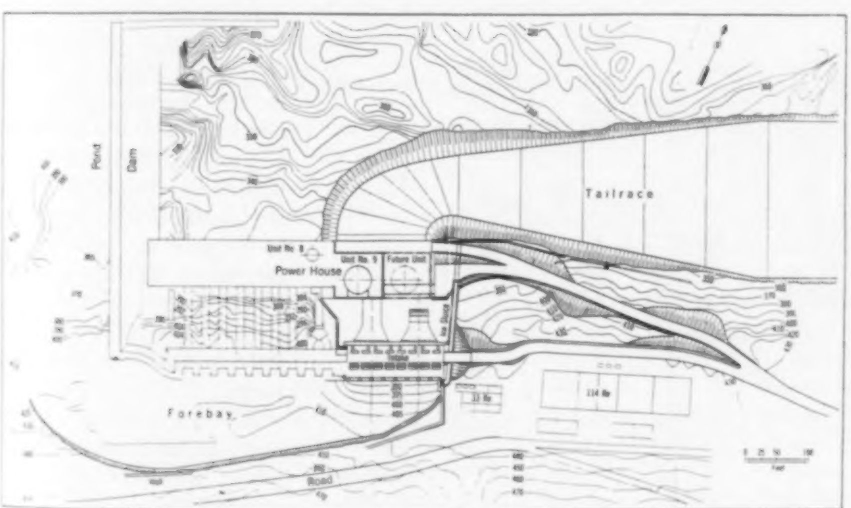


Fig. 1. General Plan of the Spier Falls Development

NEW POWER HOUSE ADDED TO EXISTING PLANT

In order to place No. 9 unit as near as possible to the existing No. 8 unit, a portion of the old power house, originally constructed for additional units but not used, was demolished. A view of the remaining part of the old building and of the new building as both appear at the present time, and a closeup of the new structure are shown. It will be noted that the bottom of the draft-tube outlet of the new unit is 15 ft. lower than that of the old power house. This change in depth immediately adjacent to the existing structure necessitated extraordinary care in construction.

In Fig. 2 is shown the cross section of the power house and in Fig. 3 a plan layout. The substructure is of heavily reinforced concrete and the superstructure of steel and brick. Except for difficulties introduced by the large size of the water passages and the heavy loads to be transmitted to the rock founda-

tions, there are only two unusual features in the design of the substructure.

It was thought desirable to enable the operators of the plant to have access to the water wheel at all stages of tailwater for purposes of inspection or repair. For this reason, steel shutters, similar in construction to those already mentioned in describing the intake, were provided to make possible the closing of the draft-tube openings against the tailrace water, and deep-well type pumps were installed to partly or completely unwater the draft tube. These shutters are operated from a platform in front of the power house, which at the same time affords vehicular access to the old power house.

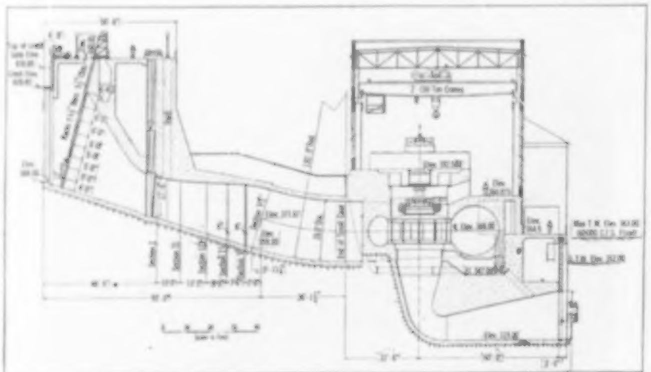


FIG. 2. CROSS SECTION THROUGH THE NEW POWER HOUSE

PROVISION FOR SCROLL-CASE DEFORMATION

The other unusual feature was the provision of means for the steel scroll case to deform freely under varying load conditions or water hammer blows without stressing the concrete floor of the power house. Above the horizontal axis of the scroll case, for a distance of about two-thirds of its circumference—in other words, where the diameter of the scroll case was large enough to be appreciably distorted—a layer of corrugated sheet asbestos, $^3/_4$ in. thick, was placed over the steel plate. This, in turn, was covered with a layer of waterproof paper over which the reinforced concrete floor was poured. This corrugated asbestos sheet is of sufficient strength not to collapse under the weight of the concrete, but it collapses under a pressure considerably below that resulting from water hammer blows and, therefore, will not transmit stress to the floor structure.

Excavation for and construction of the power house substructure was carried out inside of a crib cofferdam faced with steel sheet piling on the outside, the cofferdam being so located in the existing tailrace that operation of the old power house was not restricted by it. The bottom of the river consisted of a layer of heavy boulders and sand, into which it was impossible to drive the sheet piles to a sufficient depth to prevent seepage of water into the pit. This seepage was large at the beginning of the operations but, after grouting and the placing of a sand-bag blanket around the cofferdam, it was reduced so that the handling of the seepage water could be done with a reasonable amount of pumping.

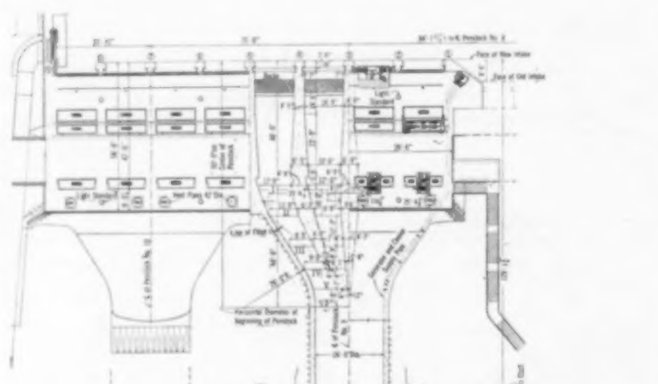


FIG. 3. PLAN OF THE NEW POWER HOUSE

After the substructure for unit No. 9 was constructed, the owner decided to construct also part of the substructure for the future unit No. 10, so that, when this unit is installed, it will not be necessary to build a cofferdam. Therefore, enough of the front part of the substructure for this unit was built to be stable as a dam when the shutters at the draft-tube outlet are placed in position and the water pumped out from the excavation behind.

COMPLICATED FORMS BUILT TO SPECIAL DESIGNS

Form work for the intake, transition, and draft-tube water passages was very complicated, as can be judged by Figs. 2 and 3. These forms were, therefore, built at some distance from the work where there was sufficient level space to construct them in their full extent according to special designs made for the purpose. They were then cut into suitable sections to facilitate transportation and handling. Some of the form sections weighed as much as 15 tons apiece. When inspected and accepted they were properly braced for transit, skidded to the vicinity of the work, and handled by derricks into their ultimate position.

TAILRACE EXCAVATED TO INCREASE HEAD

Before the construction of the present addition, there was a substantial loss in head, at discharges above 5,000 sec-ft., between the tailrace level of the Spier Falls plant and the head of the Sherman Island pond. With the increase in the discharge at Spier Falls, it became necessary to improve this condition. Elaborate studies were made on the economical size of the tailrace in order to balance the cost of enlargement against gain in head, and the size and shape shown in Fig. 1 were ultimately decided upon.

Since the river bottom consisted of closely packed, heavy boulders overlying, and intermixed with sand, it was at first thought that it would not be possible to excavate this material except in the dry by means of cofferdams. However, before starting this very expensive method of con-

struction, it was decided to try to take the material out by means of a drag line. This trial was remarkably successful, and as a result the whole excavation was done by a slack-line cableway drag line, using a 2½-cu. yd. bucket. The total excavation in the tailrace was about 70,000 cu. yd.

UNUSUALLY LARGE MACHINERY

The water wheel is a Francis-type vertical-shaft turbine rated at 57,000 hp. under 81-ft. head, 81.8 r.p.m. The scroll case is of steel plate construction, having a diameter of 26 ft. at its junction with the concrete penstock. The equipment includes all the usual auxiliaries, regulators, and governors, the arrangement of which is shown in Fig. 3. The diameter of the wheel at the throat is 19 ft. 2 in., or the same as that of those furnished for the Dnieperostroy Development in Russia, but the runner is 8 in. higher, making the physical dimensions of this wheel the largest in existence. Its weight is 140 tons without the shaft.

The three-phase 60-cycle generator is of the umbrella type, with revolving poles, rated at 47,000 kva., and generating at 13,800 volts. It is equipped with direct-connected main and pilot exciters. The rotor is 31 ft. 4 in. in diameter and weighs 220 tons. The outside diameter of the stator is 37 ft. and the outside diameter of the air duct is 43 ft.

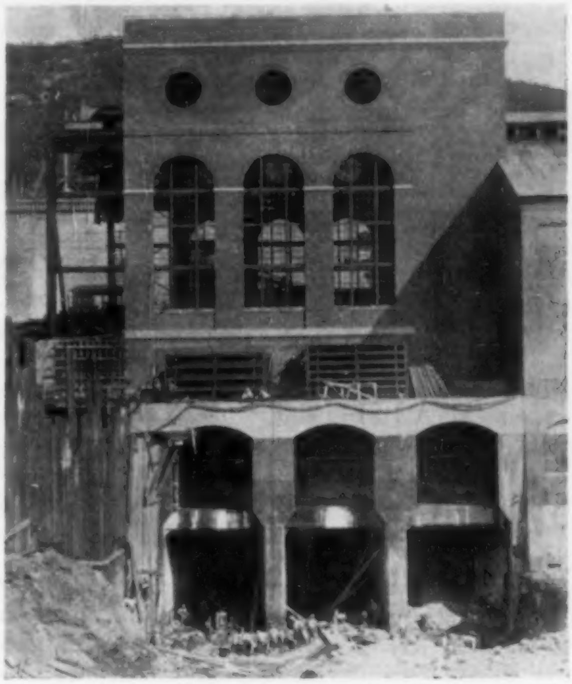
An umbrella-type generator was decided upon because studies indicated that, due to the location of the bearing underneath the rotor, it would save about 9 ft. in the height of the power house. Its construction is of the welded steel type. An enclosed ventilating system was used, with 12 water-cooled radiators spaced equidistantly around the circumference.

For the handling of the machinery, two electrically operated 150-ton capacity traveling cranes are provided. Either crane can lift the water-wheel runner, but both are required for the lifting of the rotor. The fact that this can be done without the use of a lifting yoke materially assisted in reducing the height of the building.

TAINTER GATES AND FLASHBOARDS INSTALLED

The available spillway is approximately 820 ft. long, extending from the north end of the bulkhead section of the dam to the north bank of the river. New construction consisted in the installation of 16 Tainter gates 8 ft. high, one 12 ft. long, and fifteen 27 ft. long; and of 11 bays of wooden flashboards, 27 ft. long and 8 ft. high, held by steel needle beams. The piers supporting the trunnions of the Tainter gates and the operating bridge are 3½ ft. thick and are tied down to the original masonry structure by steel dowels. The gates are operated by means of a traveling hoist and the flashboards are released by jacking up the needle beams. Grooves are provided in the piers, upstream from the gates and flashboards, in which steel-pipe stop logs can be placed should repairs be necessary.

In order to keep the Tainter gates and flashboards free from ice and therefore in operating condition at all times, compressed air at 5-lb. pressure is carried through the pipes of the bridge railing into pipes embedded in the concrete of each pier, the air discharging just upstream of the gates or flashboards near the crest of the dam. The air bubbles rising to the surface prevent the freezing of the water next to the gates and flashboards. During the past winter the operation of this device gave perfect satisfaction.



THE NEW POWER HOUSE
Substructure and Superstructure

ACKNOWLEDGMENTS

The design was made by Parsons, Klapp, Brinckerhoff, and Douglas, of New York City, under my direction. The designing engineer was Eugene E. Halmos, M. Am. Soc. C.E., assisted by H. A. Foster, Assoc. M. Am. Soc. C.E., the detailed design being in charge of S. R. Apt. Approval of the design, all electrical work, purchase of machinery, contractual relations, and supervision of the work were in charge of J. D. Whittemore, Executive Engineer of the New York Power and Light Corporation, who was assisted by S. O. Schamberger, Assoc. M. Am. Soc. C.E., Hydraulic Engineer, and by C. A. Bacon and C. A. Miller, electrical engineers. The consulting architects were McKim, Mead, and White, of New York City. The construction work was done under contract by the Allied Engineers, Inc. (then Stevens and Wood), with J. C. Balcomb, M. Am. Soc. C.E., General Superintendent.

RESPECT YOUR PROFESSION

"It is well for a man to respect his own vocation whatever it is and to think himself bound to uphold it and to claim for it the respect it deserves."

—*Charles Dickens*

The Civil Engineer's Part in the City Plan

Cooperation Needed with Architects and Landscape Designers

By Morris Knowles

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IN THIS country, the work of the civil engineer began on the frontier, building a nation. Later when, in planning street layouts and developing public utilities, he came into city planning, his early training caused him to measure the worthwhileness of endeavor by utility and efficiency. In answer to popular demand, planning is now called upon to make the city a more attractive and efficient place in which to live. This paper, here abstracted, is the concluding one of a series by different writers begun five years ago, to develop the relation of various professions to city planning. It was presented on January 22, 1931, before the City Planning Division at the Society's Annual Meeting in New York.

THE work of most civil engineers today has to do with building or rebuilding cities, or with bringing to city dwellers the things they want and need. This was not so in the early days of engineering in America. From Washington's time on through the greater part of the nineteenth century, those pioneers in what is now the profession of civil engineering were to be found, not in the towns, but out on the frontier, opening up and exploiting a vast new country and its resources. The layout of village streets or the arrangement of city lots was of small moment when there were post and military roads to be extended for hundreds of miles into the wilderness, and great tracts of fertile land, virgin timber, and mineral wealth to explore, survey, and map. In railroad development, the country to be served and the economic route were all important; the town sites were incidental accessories. The engineer was not building cities; he was building a nation.

PROBLEMS OF GROWTH

As a consequence of this sort of training, when the engineer later turned to city building it was but natural that, in designing his structures, he should apply all his skill and ingenuity toward securing the lowest possible cost consistent with safety and usefulness. There was much to be done, and capital was limited. So the ability of the engineer was judged by how far he could make a dollar go.

Toward the end of the nineteenth century, with the rapid development of American industry and its centralization in cities fed by an increasing flow of immigration, it was realized that industry and urban growth had created problems quite different from those which exist in a country village. Groping for solutions, the sociologist began to show interest in better housing; the architect in civic design; the landscape architect in public parks; and the lawyer and economist in improved forms of municipal government. The engineer directed his energies particularly toward those problems of water supply and sanitation which, though of small concern in the days when population was scattered, were now found to be vital to the protection of life and health. However, he was not only interested in the discovery of new and improved purification processes, but also in the development of sounder methods of design and of far-sighted planning—of utility systems in particular, so that they might be expanded economically as need arose.

During recent years, the mistakes of the past have become more apparent, and the problems of city development more acute. The term "city planning" has given expression to the growing demand for national town planning, with greater foresight, better coordination, and more attention to the community as a worth-while place for living as well as for working.

I use the term "planning" here in a comprehensive sense as referring to the conception and design of a project which provides for the future. The term "city planning" must be understood to mean the planning of any type of community—the town, city, county, or region—while "civil engineer" here refers to the engineer engaged in city or community building, that is, in public works and related activities.

Planning, of course, has not come merely as the result of an inadequate sewer system, of an unsuitable water supply or a too narrow street. It is the result of an unrest which has lately taken form as a protest against artificial barriers to the full enjoyment of life. People have too long been forced to endure conditions which prevented them from getting the most out of existence. As in other peoples of other times who have suffered oppression, so in the people of today the spirit of revolution has awakened a demand for their rights which, in this generation, they interpret as more pleasant urban living conditions.

INVASION OF PLANNING FIELD

While the engineer was the original city planner, he no longer has the field to himself. His training qualified him for such elemental phases of planning as lot subdivision. From this he went on, not only to study the street system as the backbone of the city, but also to develop other public works, such as utilities, sewerage, and water works systems, which are the life blood of communities. In all these things he had necessarily looked to the future and considered the probable growth of cities and their needs for many years to come.

Thus the engineer became a true planner of public improvements. As such he prevents the undoing in the future of that which is done today, often declared to be the main purpose of planning.

The engineer has lost his former position as the only city planner, due to a number of circumstances, one of

which is his intensely practical outlook—an attribute to be somewhat commended, as will later be observed—and another is his failure to appreciate the public's laudable desire for the esthetic and the beautiful. Too often, in the past, the engineer found it easiest to lay out a street system in a purely rectangular fashion, regardless of the gradient or amount of cut and fill; or, when he was designing a great water works installation, he found it expedient to ignore the fact that the public would heartily approve the expenditure of some money for appropriate architecture and an attractive landscape setting.

In other words, he has too often failed to realize that public money is more wisely spent in making public work properly attractive than it is in buying new property simply for the purpose of adornment and recreation. It is better to utilize an existing water works site for a playground or park, if properly located, than it is to begin all over again by acquiring new property.

ECONOMY CAN BE A FAULT

There are elements of city planning that are not in the field of engineering, but which engineers could have taken over, to the enrichment of the work they have done. Engineers have been lamentably unwilling to spend money for esthetic purposes, to invest their works with cultural value, or to design for anything but dead and live loads.

The demand, on the part of an awakened public, for improvement and for a change in methods of engineering work is not a demand for a change in engineers. The remarkable achievements of the past one hundred years in engineering and industry are about to be followed by greater achievements along social and cultural lines.

Although the World War was a long step backward in the march of world progress, out of it may have come a realization of the spiritual incompetence of science and engineering, when misapplied and misdirected. It may also have brought the new demand for improved engineering along a slightly different line—the accent of beauty and the elision of the commonplace.

Point was given to this view in the James Forrest lecture, delivered by Sir James Alfred Ewing, at the Centenary of the Institution of Civil Engineering, London, June 1928. He said:

"War has demonstrated the moral failure of applied mechanics. They had not changed man's soul but rather, through war, those gifts by which the engineer had enriched the world had been prostituted to ignoble use. The succeeding century will advance, not under the guidance of the engineer, but by the education of judgment and conscience. The world has misapplied the endowments which it owes to the engineer and in men's untrained and unchecked hand those gifts have achieved a monstrous potentiality for the destruction of mankind."

THE ENGINEER'S PLACE IN THE FUTURE

The coming relation of the engineer to city planning will depend upon his ability to recognize that considerations other than utility will in the future have a more and more prominent place in municipal construction. But his practical training has been and can be of real advantage if it is properly directed and utilized.

All too often we hear of city plans that repose on shelves and in the files, practically forgotten, and we wonder why it is. The answer is frequently found in the fact that the esthetic planner has been too ambitious and has let his mind run away with thoughts of attractiveness. He has not cut the coat according to the cloth, having forgotten or failed to learn the limitations of municipal appropriations and the need to observe certain legal requirements as to the amount of taxation and bond issues. People have been enthusiastic—and even awed—by the grandeur of possibilities and then suddenly lost all interest when it was discovered that there was no way in which to raise money for needed improvements.

From the very nature of his training, the practical engineer is not likely to make such a mistake. He has been trained in a hard school to make ends meet. He knows that he will soon be out of a job if he makes estimates on public improvements too low, and before completing the project must go back and ask for more money. He has had the experience of preparing budgets for boards of directors and city councils, and of proving that such budgets will come within their allowance and can be met out of existing or anticipated revenue.

LONG-TERM FINANCIAL PLAN

It is more and more becoming the custom to prepare a long-term financial plan, as well as a physical plan for a community, in order to show not only the desire for, and the benefit to be gained from contemplated improvements, but also the reasonable expectation of paying for them without undue increase of taxation. Who is better fitted to carry out such a practical system than the engineer who has been schooled in the hard experience of having to show cause why his estimates for public improvements should be accepted as a guide for municipal appropriations?

With a properly drawn financial plan—upon which as much thought is spent as upon any other part of the city plan—there should be funds available for investing public works with cultural as well as structural worth. The engineer will not be required to build, for one dollar, structures that, to be built adequately, require two dollars. Utility will not be the only measure of value.

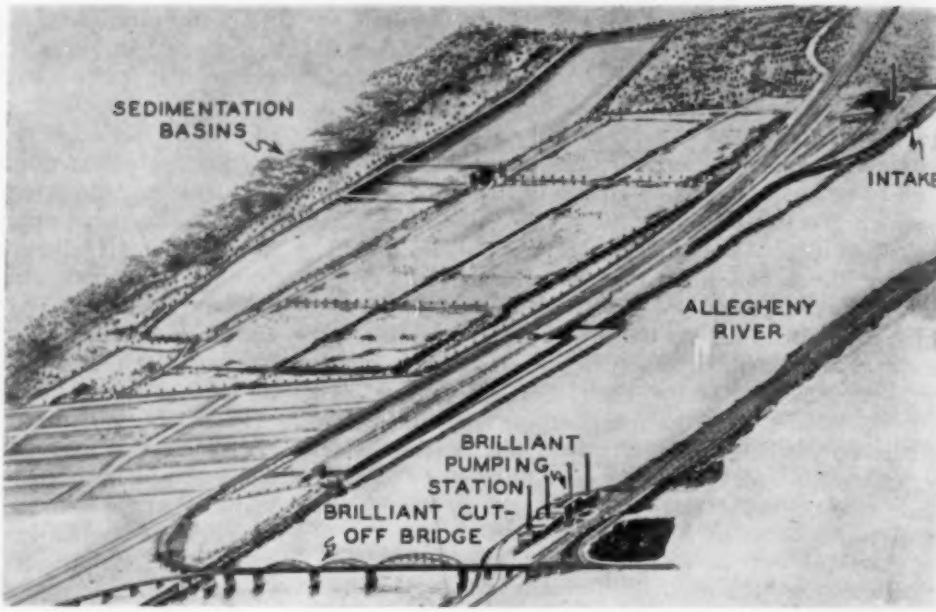
Just as the first problems of city planning—the layout of street systems and the building of the essential utilities—were of an engineering nature, so the future, with its planning of regions and regional development, will devolve again upon the engineer. The big problems of future planning have to do with the conservation of natural resources.

WATER SUPPLY PROBLEMS

For example, in every direction throughout the country, large centers of population are reaching out for new water supplies. New York is looking to the headwaters of the Delaware, and Philadelphia to the western sources of that same stream. Boston is flinging a tunnel halfway across the State of Massachusetts to get waters naturally tributary to the Connecticut River, and Los Angeles will have its aqueduct to the Colorado River. Engineers are planning these works, and they are studying the problem of water supply for other large cities.

Not only is it fundamentally their work, but it is also essentially a strong feature of regional planning.

In the development of these resources there must be vision and imagination to picture the future adequately and to plan wisely. The engineer will be called upon to forecast populations. This demands resourcefulness and capacity to profit from the advice of sociologists, biologists, statisticians, and experts in the field of public health. We have seen, in the case of some of the cities which are seeking new water supplies, that objections have been raised by adjacent regions that have called upon the law to protect their own interests in those same water supplies. So the engineer who plans these works will require the advice of the legal profession.



PITTSBURGH FILTRATION WORKS, 1908
Department of Public Works, Bureau of Filtration

NEED FOR A NEW POLICY

In the selection of natural resources for development, the engineer is called upon to make and create a policy. To commit a region to the course of seeking unpolluted sources of water supply while condemning other streams to use as drainage arteries has been his privilege; and it is now within his province to make decisions concerning the extent to which a region shall go in the disposal of its wastes.

The common measure of value or cost is the dollar; but city planning demands that this be modified, or that a price be put upon culture. It also demands that science be applied toward the creation of an environment that makes enjoyable living possible.

In the field of sewage disposal particularly, the engineer has been guilty of recommending the very least degree of treatment compatible with the prevention of nuisance, instead of a complete process for the preservation, as far as possible, of original conditions in the streams. To reinforce such recommendations of incomplete measures he can call upon science, which has devised dilution factors and minimum oxygen requirements, but frequently he neglects esthetics, with its other standards which should also be met.

No longer will the sole criterion be to meet the minimum sanitary requirements for preventing nuisance and lessening the danger to public health. In the future the demand will be for water courses so utilized and made available for development that they will become recreational units in the life of the countryside.

PROBLEMS TO BE CONSIDERED

Disposal of waste materials from our congested and highly developed civilization presents one of the most perplexing problems confronting the engineer. While it may be difficult to argue that a sewage treatment plant is an economic necessity, the new spirit of planning has come to relieve the engineer of that difficulty and to point out that it is a social necessity, imperative to the general welfare. In the future, the engineer must think not merely in terms of minimum requirements, but also of potentialities for enjoyment. The new science will place a price upon culture and give it weight in the scheme of things.

For the full development of a cultured civilization, the necessity of the proper environment must be patent. It is the individual's reaction to beauty which results in the development of good taste. Attractiveness of design, suitability of purpose, and harmony in location in building a city make it the backdrop for enjoyable and cultured living.

COORDINATING ALLIED PROFESSIONS

Engineers have not been totally lacking in appreciation of these elements. There are great bridges, tunnels, and other structures which, by their harmony with nature's plan, command admiration of, and respect for, the engineers who were their authors. The existence of such structures augurs well for the future of city planning and for the successful participation in it by the forward-looking engineer. It is a common saying that planning is not a single profession, but a well balanced coordination of several allied arts and professions. Only by working together, each realizing his own limitations and the gain to come from the experience of others, can we succeed in achieving the well coordinated development of our municipalities, and in so planning our communities that they will fit in with the needs of industry, business, and living.

The engineer should appreciate the fact that he has much to learn from his esthetic friends, the architect and the landscape designer. Only when he realizes the limitations imposed by his intensely technical training and supplements his own practical sense of financial proportion with an appreciation of the wide-spread desire for the beautiful in planning, will he reach the highest possibilities afforded him.

Preventing Erosion Below Overflow Dams

Experience with Natural Pools and the Hydraulic Jump

By Robert F. Ewald

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Hydraulic Engineer, Aluminum Company of America, Pittsburgh

Flood flows over high dams contain enormous energy that must be expended and absorbed in friction on the toe of the dam, in erosion of the river bed below, or in a water cushion. If this energy can be absorbed in the work of creating the hydraulic jump without assistance from river channel friction, there is no likelihood of failure due to erosion. During the past twenty years the Aluminum Company of America has recognized the seriousness of the effect of high overflow velocities on the safety of its dams. In this article, abstracted from a paper presented on January 22, 1931, at the Annual Meeting of the Society in New York, Mr. Ewald gives the results obtained by his studies and draws a preliminary conclusion.

Where physical conditions permit the most favorable development of water power and water storage propositions often requires the construction of dams of great height. The problem of successfully absorbing, without damage, the enormous energy that may be developed during flood flows is one of the more important connected with their design. Several modern dams of relatively low height have failed as a result of erosion at the toe, and it is a significant fact that there are no survivals among the great masonry dams of antiquity. Some of these were more than a hundred feet high, far more massive than the ancient bridges and walls, of which many examples still exist, and four or five times more massive than modern dams of equal height. The almost complete disappearance of these ancient dams, after many centuries of use, seems in most cases to be due to collapse following long-continued erosive action.

Inasmuch as several modern dams are believed to have failed as a more or less direct result of erosion at the toe, and others only a few years old now require, or soon will require, the expenditure of considerable sums of money to correct the effects of erosion, this subject presents itself as one of much importance. The conditions governing each phase of the problem are so varied that a wide spread and thorough presentation of information on the part of all hydraulic engineers is necessary to obtain a thorough understanding of it. It appears to be time that the correct principles be firmly established by general agreement of the best engineering minds.

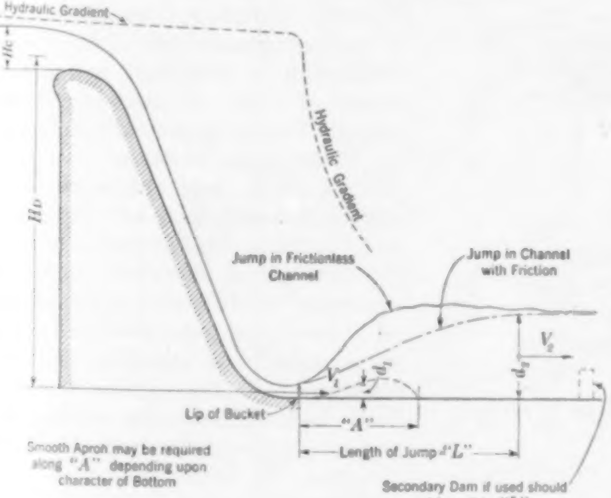


Fig. 1. The Hydraulic Jump

The Aluminum Company of America, through its subsidiaries, has built several hydro-electric developments which include overflow dams and spillways with exceptionally high falls, and has had to solve a number of problems connected with the handling of water flowing with velocities that in many cases exceed 100 ft. per sec. It will, therefore, be of value to present the experience of that company with structures in actual operation, emphasizing those problems for which it is believed satisfactory solutions have been obtained.

Significance of the Hydraulic Jump

In 1911, this company, through subsidiaries, began the acquisition of water-power rights along the Little Tennessee River and its tributaries in eastern Tennessee and western North Carolina. Preliminary studies indicated that it would be desirable to develop the power by a series of dams, some of which would be 200 ft. or more in height, and that in all cases it would be necessary to use these dams as spillways. It was early realized that erosion at the toes, due to high overfall velocities, would constitute a serious problem because some of the dams would have to pass floods of 200,000 sec-ft. or more; provision would have to be made for safely absorbing, at times, more than 4,000,000 hp. of kinetic energy. This difficulty was complicated by narrow gorges, necessitating concentration of flow to a marked degree. Spillway depths of 20 ft. or more had to be considered although they were at that time far beyond precedent.

In 1914, during the course of my investigation on a model of one of the 200-ft. dams, built to a scale of $^1/_4$ in. = 1 ft., the idea was developed that the principles of the hydraulic jump could be readily applied to the solution of the problem. It appeared that the presence of the jump at the toe of a dam was a matter of great significance. In absorbing internally the energy of water flowing at high velocities, certain general principles must be followed to insure the development of the desired jump. These principles were given consideration in the design of the Tallahassee Power Company's Narrows and Cheoah dams.

plant is an economic necessity, the new spirit of planning possibilities afforded him.

APPLICATION OF THE HYDRAULIC JUMP

In a frictionless channel, the relation between the velocities and depths at the beginning and end of the jump, as represented by Fig. 1, are given accurately by the Belanger formula:

$$d_2 = -\frac{d_1}{2} \pm \sqrt{\frac{2V_1^2 d_1}{g} + \frac{d_1^2}{4}} \quad . \; . \; . \; [1]$$

I have used an approximate and shorter form proposed by Merriman:

$$d_2 = 2\sqrt{\frac{d_1 V_1^2}{2g}} \quad . \; . \; . \; . \; . \; . \; . \; [2]$$

In the formula and in Fig. 1:

d_1 = depth of steam at beginning of the jump, in feet
d_2 = depth of stream at downstream end of jump
V_1 = velocity corresponding to d_1 in feet per second
V_2 = velocity corresponding to d_2 in feet per second
g = acceleration of gravity = 32.2 ft. per sec. per sec.

Equation 2 will give results about 20 per cent in error when the ratio of d_2 to d_1 is 2, and about 3 per cent in error when the ratio of d_2 to d_1 is 10. In practically all cases affecting flow at the toe of spillways, the ratio of d_2 to d_1 will equal or exceed 10, so that Equation 2 may be employed with satisfactory results. On low dams, with great depths on the crests, Equation 1 should be used, as Equation 2 results in excessive values for d_2.

As confirmed by experiment, the jump in its complete form requires a very appreciable length of channel, probably not less than five times the height of the jump. However, most of the change from high to low velocity is rather abrupt and, if we could be sure that at the toe of a dam there would always be sufficient depth of water to permit the formation of the jump without any aid from channel friction, only a very short apron would be required at the transition section.

Where there is not sufficient natural depth of water to permit the formation of the jump without the aid of channel friction, the slope of the jump is much flatter, as shown in Fig. 1 by the line designated "jump in channel with friction." The slope then becomes the physical expression of a very complicated relationship between channel friction and the factors in the theoretical formula. Obviously, if channel friction is required to develop the jump, erosion must occur within the jump if V_1 is very high. These are the conditions that give the engineer concern.

The great importance to the engineer of the jump in its theoretical form is that it affords a criterion which tells him whether or not elaborate works will be required to prevent erosion. If the hydraulic conditions are such that the jump is formed without the aid of channel friction, practically all the energy of the water flowing at high velocity is completely absorbed without effect upon the channel.

In general, the gravity-type dams built by the Aluminum Company of America have not included special features built to develop the jump in the theoretical form, but these dams have in all cases been carefully studied with respect to the possibility of damage by erosion, and in regard to the ultimate formation of the jump in naturally eroded pools, so as to affect in no way the stability of the structures. The development of these pools, under conditions which were obtained at some of the dams discussed here, is a very slow process and, after 15 years, the data obtained are relatively meager, although they are believed to be of real significance.

EXPERIENCE AT NARROWS DAM

The Narrows power development, belonging to the Tallahassee Power Company, a subsidiary of the Aluminum Company of America, is located on the Yadkin River near Badin, 40 miles southeast of Salisbury, N.C. The drainage area above the dam is approximately 4,000 sq. miles. The dam is a gravity-type concrete structure, slightly arched, with a maximum height of 216 ft. from foundation to walkway, and a crest length of 1,150 ft., and is provided with 22 Tainter gates, each 26 ft. wide by 12 ft. high, as shown in Fig. 2. With a 12-ft. depth of water on the crest, water surface at 541, these gates will discharge 87,000 sec-ft. Around the left end of the dam there is a wasteway 100 ft. wide, provided with 10 Stoney-type gates which, with the water surface at elevation 541, will discharge 150,000 sec-ft. The total flood discharge capacity of the dam and by-pass, with the water surface at elevation 541, is 237,000 sec-ft.

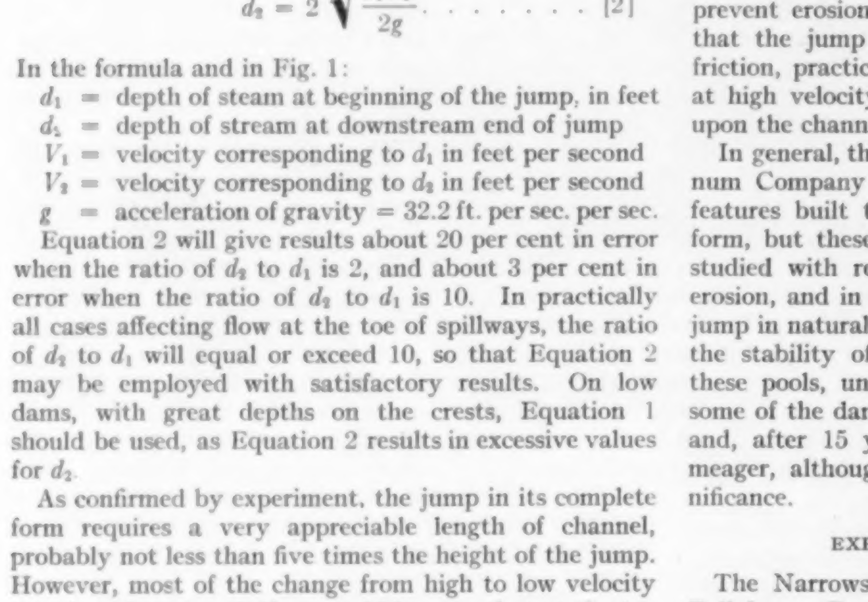


FIG. 2. NARROWS DAM, YADKIN RIVER

When the plans for this development were being prepared, it was the intention to discharge all flood flows up to 150,000 sec-ft. through the by-pass, taking all flow in excess of that amount over the crest of the dam. This method of handling floods was adopted because the dam is located in a shallow section of the river on a rock ledge that is somewhat broken, and, without sufficient

cushioning, it appeared certain that serious erosion would occur at the toe of the dam. To obtain the required cushioning, it was proposed to discharge as much water as possible through the by-pass. This in turn would produce backwater at the toe of the dam and thus establish a relatively deep cushion for the water discharged over the dam.

On account of damage to the wasteway channel by the discharge of a 35,000 sec-ft. flood in 1919, the gates on the dam had to pass all flood flows during the years from 1920 to 1925 inclusive, and some interesting conditions developed relative to erosive action at the toe. It is evident from the cross sections taken, of which Fig. 3 is typical, that erosion had occurred continuously, but at greatly varying rates, since the completion of the dam.

At its highest section, the average drop is 171 ft., so that the average velocity of the water when it leaves the "bucket" is approximately 100 ft. per sec., and the thickness of the sheet of water is 1.58 ft. With values of v_1 = 1.58 ft., the formula for the jump, Equation 2, shows that a depth of at least 31.3 ft. is required to absorb the overfall velocity at the toe when the crest depth is 12 ft. Four large floods have been taken over the dam since its completion in 1917, and flow and erosion data on them are summarized in Table I.

The irregularities in the variations in depth of the water at the toe of the dam depend on the amount of water taken through the by-pass. At times the depths of water, as fixed by the channel rating curve, have not been sufficient to permit formation of the jump without the aid of channel friction. The deficiencies, however, have been relatively small, that is, less than 10 ft., and it is significant that the erosion has averaged less than that figure.

The floods of October 1924 and October 1929 have peculiar importance. In the former, owing to deficiency in depth, erosive action was increased to a marked degree, especially at points along the toe of the dam. In the latter, the extra flow carried through the by-pass was sufficient to give ample depth, and for practically the same flow as in 1924 there was no erosion. In many cases material was deposited along the dam where erosion had been taking place in the earlier flood. As the bottom has now been eroded to the requisite depth, stable conditions have been established and no further erosion is expected.

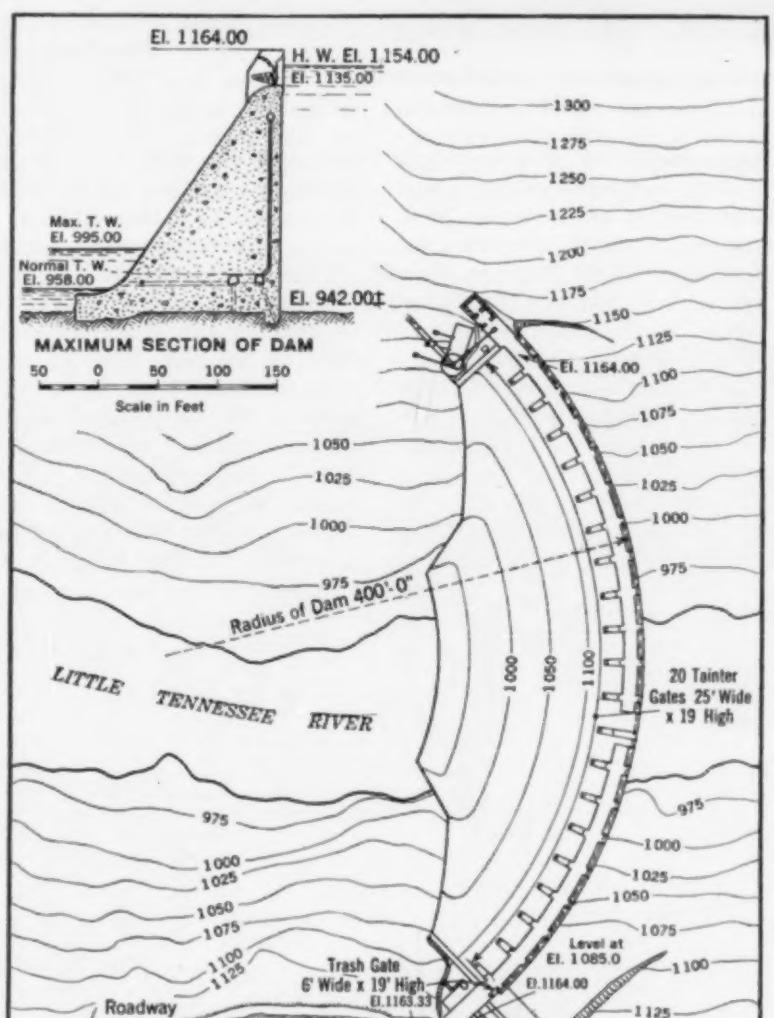


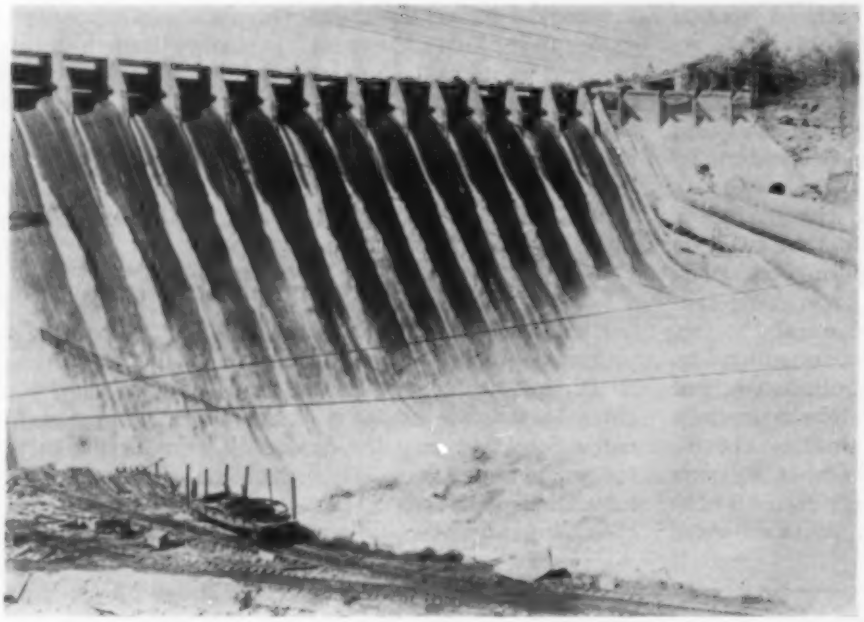
Fig. 3. Cheoah Dam, Little Tennessee River

EROSION EXPERIENCE AT HIGH ROCK DAM

High Rock Dam, completed in 1928, fourteen miles upstream from Narrows Dam, raises the water level 59 ft., and its crest is provided with ten Stoney-type gates 45 ft. wide by 30 ft. deep, which will carry the entire flood flow past the dam. Water velocities at the toe are 55 ft. per sec. While the initial velocity is much lower than at Narrows, the depths required to develop the jump are practically the same. By distributing the flow uniformly through all the gates, it is possible to maintain sufficient depth at the toe to develop the jump for flows up to 50,000 sec-ft., but for flows in excess of that figure there is a considerable deficiency under certain conditions. Since completion in 1928, six floods in excess of 50,000 sec-ft. have been taken past the dam. Considerable erosion has developed, in fact as much as at Narrows Dam, despite the lower velocities and a life of only 2 years as compared to 13 at Narrows. The errosion, however, has in no case been deeper than that required to permit the jump to develop without the aid of channel friction. By the proper distribution of flood flows throughout the length of the dam, erosion should not go below a definite and safe limit.

YADKIN FALLS SHOWS LITTLE EROSION

Completed in 1919, Yadkin Falls Dam, $2^1/_2$ miles downstream from the Narrows Dam, raises the water



NARROWS DAM DISCHARGING 40,000 SEC-FT.
September 1917

level 50 ft. Its crest is provided with 10 Stoney-type gates 33 ft. wide by 10 ft. deep and two shallow Tainter gates. Water velocities at the toe approximate 50 ft. per sec. Since its completion in 1920, this dam has taken care of the same flood flows as the Narrows Dam. Opposite four of the gates there has always been sufficient natural water depth to permit the formation of the jump without channel friction. In this length most of the flood flows have been passed, but no erosion whatever has been found; in fact, material has actually been deposited over much of the river bed. It is significant that the natural depths are but little greater than those actually required. Opposite the other six gates the available natural depths have not been sufficient and considerable erosion has developed.

NATURAL POOL PROTECTS CHEOAH DAM

Cheoah Dam, on Little Tennessee River, raises the water 194 ft. It is founded on a very hard, fine-grained metamorphic sandstone with occasional thin beds of slate. As usual with very dense rocks, the upper strata are broken up to an extent which permits raveling with velocities in excess of 25 ft per sec. The dam is provided with 20 Tainter gates, each 25 ft. wide by 19 ft. deep, as shown in Fig. 3, and is designed to care for 160,000 sec. ft. The velocities at the toe are 105 ft. per sec.

Since its completion in 1919, the Cheoah Dam has carried water over its crest for a much greater percentage of the time than the Narrows Dam and at much greater depths, 19 ft. as compared to 12 ft. at Narrows. However, for flood flows up to 50,000 sec-ft., the natural depth of the pool at the toe has always been sufficient to develop the jump. The erosion is relatively small, averaging not over 5 ft., and apparently it all took place in 1920 when a flow of 70,000 sec-ft was carried over the dam. As the margin between available depth and required depth, with flow distributed to best advantage, is less than 10 ft. at all stages of flow, no further erosion is expected. Figure 5 shows the erosion.

It has been noted that, at the Narrows Dam, in October 1929, at four gates of the Yadkin Falls Dam throughout its history, and at the Cheoah Dam since 1920; loose material has been piled against the toe at those times when sufficient depth was available to develop the jump without the aid of channel friction. This appears to lead to the conclusion that, at the toe of ogee spillway dams, when sufficient depth of water is available to permit the jump to develop without the aid of channel friction, dangerous erosive action directed at the toe is completely absent, vindicating the preference of many engineers for the ogee type as compared to the straight drop.

The absence of a water cushion leads to extremely

TABLE I. FLOOD FLOWS AND EROSION AT NARROWS DAM

Date of Flood	Sec-Ft. Over Dam	Sec-Ft. Through By-Pass	Total Sec-Ft.	Normal El. W. S. Below Dam	Required Depth in Ft. to Develop Jump	Required Bottom El. of Channel	Actual Elevation at Bottom of Channel: At Beginning of Flood, Av. el.	Min. el.	At End of Flood, Av. el.	Min. el.
Sept. 1917	40,000	0	40,000	373	28	345	355	348	*350	*342
July 1919	55,000	35,000	90,000	380	31	349	*350	*342	350	342
Oct. 1924	55,000	0	55,000	374	31	343	350	342	348	342
Oct. 1929	52,000	70,000	122,000	386	31	355	348	342	348+	342+

* No complete survey was made until after the July 1919 flood, but a few soundings taken in 1917 indicate that most of the erosion found in 1919 really occurred during the 1917 flood.

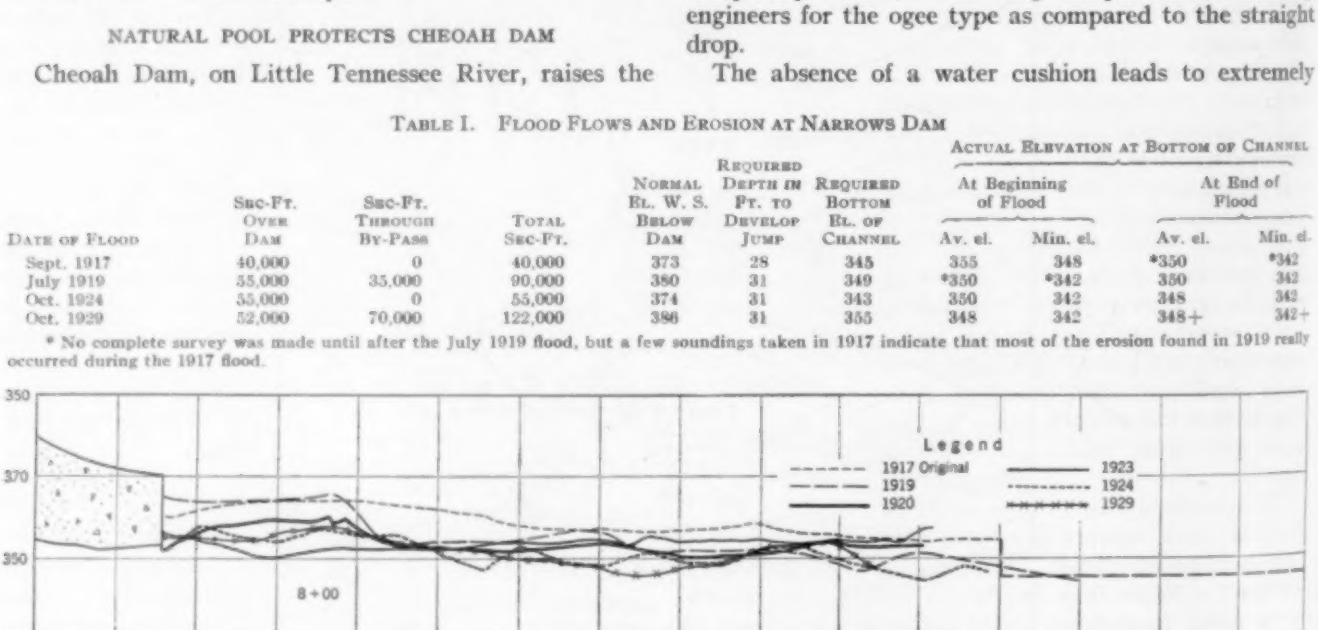


FIG. 4. TYPICAL PROFILE BELOW THE APRON, NARROWS DAM

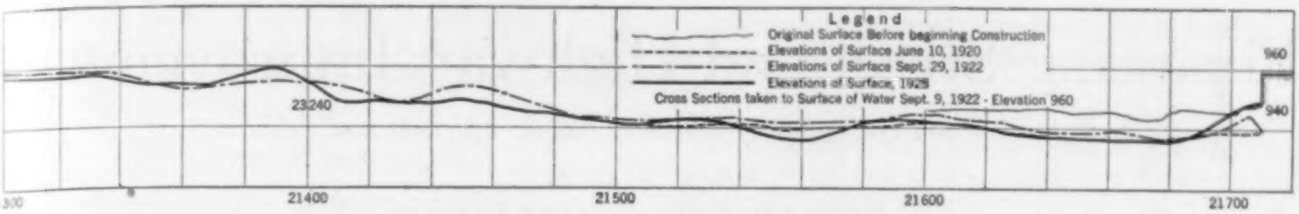


Fig. 5. Typical Profiles Below Cheoah Dam

rapid erosion, especially with velocities in excess of 35 ft. per sec., and, when assisted by the grinding action of the material already picked up, no known rock can be depended upon to be proof against erosion, even to a reasonable degree.

As a result of many tests on models, experience with the dams here discussed, inspection of other dams, and a perusal of the rather meager literature bearing on actual experience, I am convinced that energy should not be destroyed by friction or impact on any part of the dam or the immediately adjacent channels, and that the use of baffle piers, obstacle walls, or steps for the express purpose of absorbing energy is at least a very questionable practice. All surfaces in contact with water flowing at high velocities should be smooth and unbroken, even within the area where velocity changes are desired. All irregularities form the beginning points of erosive action and such erosion will continue, with cumulative rapidity, until the structure is seriously damaged—under certain conditions, it may be destroyed—or until a cushioning pool is developed of sufficient extent to halt further erosion. It is the part of the hydraulic engineer either to provide such a cushion or to make certain that nature will not carve it out of vital portions of the structures he builds. In many places it is feasible to let nature carve out a pool that will be in no way dangerous.

The "ideal" to be tried for in handling high velocities with minimum destructive action requires dropping the water within the shortest feasible horizontal distance, over surfaces made as smooth as possible, and providing the means for turning it horizontally over smooth surfaces and directing it into cushioning pools of adequate depth to form the jump.

Yadkin Falls Dam Discharging 130,000 Sec-ft.
July 1919

Financing Street and Highway Improvements

Collection and Allocation of Funds to Secure Fairness and Efficiency

By R. W. Crum

Member American Society of Civil Engineers

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With the yearly increase in the use of motor vehicles as agencies of transportation, Government authorities as well as individuals are seriously interested in the upkeep and improvement of the roads and highways of the Nation. During 1929, by means of papers and discussions at the Dallas, Milwaukee, and Boston meetings of the Society, the Highway Division conducted a symposium on the "Equitable Distribution for Highway Purposes of Motor Vehicle Licenses and Gasoline Taxes." To Mr. Crum was assigned the task of reviewing the facts and opinions presented, with a view to the recommendation of whatever conclusions might appear to be warranted. As a result of Mr. Crum's study, this paper was presented on January 22, 1931, at the Annual Meeting of the Society in New York.

The symposium on "Equitable Distribution for Highway Purposes of Motor Vehicle Licenses and Gasoline Taxes," conducted by the Highway Division during 1929, brought out the status of contemporary practice and opinion representative of the various governmental jurisdictions interested. That engineers in general concur in the following principles was disclosed by the papers and discussions presented in this symposium.

1. Motor vehicle users should pay a fee to cover what is called, in public utility parlance, "readiness to serve." This may be considered to represent the motorist's contribution to the capital investment, and is generally collected through license fees.

2. Motor vehicle users should also pay some amount based upon their use of the roads. This amount may represent their share of the operating costs of the highways, and is universally collected at the present time through imposts on gasoline.

3. No part of the funds raised by means of motor vehicle license fees or gasoline taxes should be diverted to any other use than the construction, maintenance, and control of highways.

Importance of These Principles

As these three principles, and especially the last, are of great importance, the Highway Division might well recommend them to the Board of Direction for approval. They do not touch upon the controversial question of the allocation of funds among the various classes of roads and streets, or governmental units. With respect to this question many well considered opinions were presented. In general, the engineers reasoned from their own experience with one or more phases of road or street work, although they recognized that the equities of the situation have not yet been defined.

At the Boston Meeting, it was emphasized that engineers should consider all of the facts and not favor any particular interest, the small town, the city, or the state highway department. This is obvious, and there is no doubt that if engineers could study the facts underlying the problem they could recommend an equitable procedure, the difficulty at the present time being that all of the facts are not available for study.

All that I shall attempt to do here, therefore, is to discuss from an engineering point of view, and without prejudice, some of the factors that appear to have a controlling effect in the equitable assessment of highway costs, and to call attention to some research projects that could aid materially in ascertaining the facts that are needed. These facts themselves will vary from place to place and from state to state, but the same methods of attack upon the problem should result in some uniformity in procedure.

Determining the Road Users' Share of Costs

The real problem is not how the funds being raised at the present time should be distributed, but rather what share of the annual expenditures on the various classes of roads and streets should be borne by motor vehicle users.

In order to determine correct amounts, sources, and distribution of funds for the construction, maintenance, and administration of any group of roads or streets, certain questions must be answered. Among them are:

1. What are the roadway costs?
   a) Cost of building
   b) Annual cost for administration, maintenance, and periodic replacement or renewal
2. What part of the costs should be borne by each of the various interests benefited?
   a) Federal Government
   b) State government
   c) Local community
   d) Adjacent property
   e) The user

Having the answers to these questions for all of the various sytems of roads and streets in a state, the grand total of what the users should pay could be added up and assessed if it is within the "ability to pay." If the entire sum could not be assessed, consideration would have to be given to the allocation of the funds raised so that they would yield the greatest good to the greatest number.

The answers will vary widely, depending upon such factors as class, type, location of roads, and traffic. The classification of roads adopted by the American Association of State Highway Officials is adapted to discussion of these questions. This classification is: (1) primary roads, comprising the Federal and state

systems; (2) secondary roads, the principal county trunk highways or state-aid highways; and (3) third class roads, the purely local township roads. To these should be added city and town streets.

PRIMARY ROADS

Primary roads are the highways providing for interstate, inter-city, and inter-county transportation, which, it is generally agreed, should be built and maintained by the state with such aid as is contributed by the Federal Government. This system, as thus far defined, stops at city limits. However, the discussions in the symposium indicate considerable opinion that the extensions of these roads into and through the cities should be considered a part of the state primary system. In so far as engineers are concerned, there can be no doubt that, in planning for the movement of traffic over primary roads, the city links cannot be neglected. So these streets will be considered in connection with the primary roads.

In any business undertaking, public or private, there must first be an outlay of capital. Then, if the enterprise is to be on a sound basis, it must earn enough to pay interest on the capital, to pay the operating and fixed charges, and to provide for anticipated renewals and replacements. In the case of a public project, such as a system of highways, the soundness of the enterprise can be assured if the governmental unit concerned levies enough taxes upon the benefited parties to provide the necessary sum each year to cover the financing of the capital outlay and the annual cost.

The rate at which a system can be built will depend upon what the benefited interests can afford, and upon whether the payments for construction are to be made directly from the tax money or from borrowed money. The reasons why the issuance of bonds for road improvements under certain conditions is sound public policy have been ably presented by Messrs. Agg and Brindley in *Highway Administration and Finance*. We are principally interested in the determination of the total annual cost so that the necessary taxes can be levied.

NEED FOR COOPERATION

The building and operating of a highway system is a huge cooperative enterprise of the people of a state, in which they must first furnish the capital, and then pay individually for the use of the facilities. Their profit comes in lowered vehicle operating costs and in other more or less intangible benefits.

At any given date, the money and time necessary to bring the entire system to the desired standard can be estimated. If the pay-as-you-go plan is followed, the tax levy for construction will naturally be whatever the benefited interests can afford each year; and if bonds are to be issued, the construction fund should be sufficient to pay them as they mature and the accrued interest. By issuing serial bonds, these annual imposts can be made uniform over any number of years.

The determination of the amounts needed per year for operating expenses and for periodic renewals is more laborious, but there is no reason why they cannot be calculated on a sound basis for any highway system. This involves computation of the annual highway cost for those parts of the system that are already completed, and estimates of the probable annual cost of the rest of the system during and after the construction period.

ANNUAL ROADWAY COSTS

The Committee on Transportation of the Highway Research Board has proposed a method for computing the annual roadway costs as of the date when the data are assembled, for any specific section of highway. This method is described in the *Ninth Annual Proceedings* of the Highway Research Board, and will be illustrated in the *Tenth Proceedings* by detailed computations of costs on two typical highways—one a section of the Boston Post Road in Connecticut, and the other in Iowa.

The annual cost of a section of highway consists of the interest on the cost of construction, or value at the time of the analysis, plus the annual maintenance cost, including administration and engineering, plus the sum that must be set aside each year at compound interest to provide money for periodic renewal or replacement. This is expressed in a formula as follows:

$$C = r\left(A + \frac{B}{r} + \frac{E}{(1+r)^n - 1} + \frac{E'}{(1+r)^{n'} - 1} + \cdots\right)$$

where
C = average annual cost
A = cost to construct
B = yearly maintenance cost
E (or E') = expenditure for periodic maintenance every n (or n') years
r = rate of interest prevailing in current financing

An estimate of the total annual cost of a highway system would have to be built up piecemeal since the factors would vary on different roads. On those sections of the system included in the construction program, the annual cost could be calculated for the date when the analysis was made and then estimated for each year in advance, until the end of the construction period. The result of such calculations would be a tabulation showing the amounts that the system would actually cost the people of the state for capital investment and for annual cost.

If this annual cost should be collected through some form of taxes, the revenue would be in excess of the expenditures, at least to the extent of the interest factor. This excess would no doubt be needed for those changes and betterments in the system that would appear from time to time.

KNOWLEDGE OF COSTS HELPFUL

Although it might not be feasible, for administrative or legislative reasons, to assess the interest and carry a sinking fund as provided in these calculations of costs, a knowledge of the actual annual cost of providing the roads would be helpful in planning both revenue measures and expenditures. These costs, after deductions for Federal aid, would be the amount that might be fairly assessed against the vehicle operators, if a state highway system were to be built and operated on money raised by license fees on motor vehicles and taxes on gasoline.

Anticipating the acquisition of fundamental data for use in this motor-vehicle tax-distribution problem, it would be a worth-while research project to have the

annual highway costs computed for all or part of a state highway system—a laborious job, it is true, but how else can such basic data be secured?

SOURCES OF FUNDS

The parties that would be benefited by the completion of a state highway system are: (1) the United States; (2) the state; (3) the local communities; (4) real estate; and (5) the road users.

The Federal Government recognizes the value to the Nation of roads that are needed for interstate transportation and national defense, so Federal aid on the construction of these highways is well established and will probably continue for some time.

Since it is generally realized that the state is the principal beneficiary of the primary system of rural highways, it is a well established principle that these roads should be built and maintained by the state organization, on money raised by the state. As the entire population is affected to some degree by the use of the main highways, it seems equitable to spread the cost over the population by means of taxes borne by motor vehicles, consisting in part of a service charge and in part of a payment proportionate to the amount of use. As far as can be determined, this arrangement appears to be acceptable to the users.

It is probable that the benefits to the local community and private property are relatively greater on extensions of primary roads into and through towns and cities than in the rural districts. But little information has been assembled to show the true relationship existing between community interests, private property, and road users. As a matter of fact, this relationship undoubtedly varies from place to place and from state to state, but a thorough study of even one case would be of immense value in pointing the way to a profitable solution in other places, and in establishing some principles of general application.

Factors needing study are: the amount of through traffic, local traffic, and public carrier traffic; the effect of through and local traffic upon the design of pavements; the use of streets for parking, this being an extensive street use that cannot be measured by a tax upon fuel; the relation of the highway to local business; and the effect of street improvement upon property values. Many data and painstaking analyses are required. If the interests of the various parties could be evaluated, it should not be difficult to secure a fair share of the cost from each.

SECONDARY ROADS

Secondary roads are the principal county trunk highways, mainly important to the immediate agricultural regions and market centers which they serve. An analysis of annual highway costs would also be valuable on roads of this class. Some of the states, recognizing that these roads are necessary to general prosperity, grant aid on important secondary projects; others take them over into the primary system when funds for extensions become available. As state money is usually derived from user taxes, these methods can be used to take care of that portion of the total cost of secondary roads that should be borne by the road user.

As the communities served are the chief beneficiaries of the secondary roads, it is usual to finance them by general property taxes. Benefits to adjacent property by secondary road improvements depend upon such factors as the extent to which the entire region is served, the character of the traffic, and the character of the improvements. Although improvement is undoubtedly a benefit to farm land, it may not be of value beyond a certain degree of all-year usableness. When the residents along a particular stretch of road desire to expedite the improvement of it, financing by means of an assessment district may be advantageous. As many secondary roads have a considerable amount of transient traffic that is of no value to the local district, the only way to get a contribution from this traffic is through state taxes affecting the user.

Studies of land values, land income, the amount and character of traffic, and the origin and destination of traffic are needed to arrive at the proportion of secondary road costs that should be borne by the various interested parties.

An investigation conducted by the U.S. Bureau of Public Roads, the North Carolina State Highway Commission, and the Tax Commission of North Carolina, entitled "A Cooperative Study of County and Township Highway Financing and Administration, and a Survey of Physical Conditions of Such Roads in North Carolina," has recently been completed and the report is now reaching final form. According to the finding of the Committee on Highway Finance of the Highway Research Board, "The report of North Carolina will go far to point out the reasons why no faster progress is being made in the improvement of secondary roads, and the principles that must be made effective if, within any possible expenditure, adequate secondary roads are to be secured."

THIRD-CLASS ROADS

Improvement of third-class roads, which exist primarily to give access to the farms of the country, constitutes one of the most pressing and difficult of highway problems. The principal beneficiary of these roads must be the farmer, because an outlet is essential to his success. However, the interest of the community in them can scarcely be less than his, for successful farms are necessary to its prosperity, and the general property tax touching both is probably fair.

In particular cases the improvement of certain roads by means of special assessment districts may be profitable to the land owners, as traffic is light and the relative share of the users, as such, in the costs is slight.

In the cities, beside the extensions of rural through routes already discussed, there are residential streets, business streets, and intra-city through routes. The residents are the greatest beneficiaries of improvements on strictly residential streets, and the practice of assessing the major part of the cost against the real estate benefited has become established as equitable.

The city at large and the users, especially public carriers, have considerable interest in business streets, which are also vitally necessary to the business houses using the adjacent property, so that their share of the cost is probably relatively large. The street railways pay for their share of the pavement and upkeep, while buses, taxicabs, and public carrier trucks have an interest

that can be assessed by the city in various ways. It is true that many of these vehicles do not operate outside the city limits although they contribute, through license fees and gasoline taxes, to the primary road system. It can be claimed in justification that the prosperity of the city is enhanced by the existence of a good system of tributary roads.

On business streets, the problem of who should pay for that portion used for parking space is perplexing. It is probable that the matter is of greatest interest to the vehicle users, although the city at large or the adjacent property may have to bear the burden. The value of street parking to business houses needs to be evaluated, and there is a great deal of evidence relating to this problem in the traffic data that have been collected in many of the larger cities.

The intra-city through highways may be a detriment to the abutting property although benefiting a zone of some width. The city at large and the public carriers have considerable interest in these streets, and it may be that the interests of the private users and the city coincide. Study of the available data, to evaluate these factors in terms of benefits to the various parties concerned, is needed as well as a study of property values and the earning capacity of real estate in the zones benefited by these streets.

NEEDED RESEARCH

This analysis has brought out the need for factual studies before sound conclusions can be reached as to the relative parts of the cost of each road or street system that should be paid by the state, the community, the adjacent property, and the users. Although it does not appear probable that the relationships can be reduced to formulas, an engineer finds such studies essential to the exercise of judgment.

Several research projects of interest in this connection are under way. For instance, the U.S. Bureau of Public Roads and the University of Wisconsin are making a study of "state, county, township, and municipal taxes for highways and the relationships between road and general property taxes in the various states." This project has for its principal objective the determination of the sources of highway income, with particular and detailed attention to the impost of taxes for highway purposes upon property, rural and urban. The study of the State of Wisconsin will be completed about July 1, 1931, and the complete outline of this investigation, which will be published in the *Tenth Proceedings* of the Highway Research Board, indicates that many facts pertinent to the problems discussed in this paper will be assembled and studied.

An important investigation of secondary road problems in North Carolina has already been mentioned. The Committee on Traffic of the Highway Research Board, in cooperation with the Policyholders' Service Bureau of the Metropolitan Life Insurance Company, expects soon to complete an investigation of "traffic survey methods and forms," which will be of value in planning for the investigations that are here suggested.

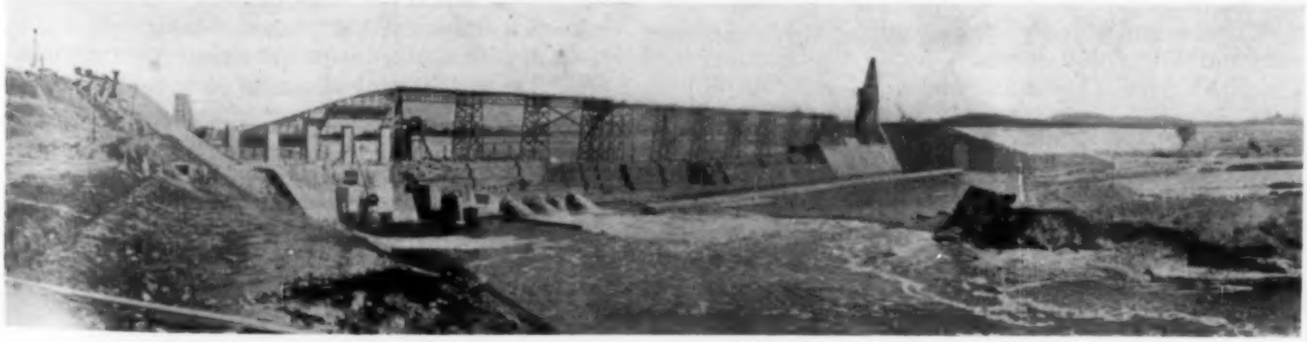
Other needed research projects are:

1. Calculation of the annual cost of all or part of a state highway system. It is expected that the Committee on Transportation of the Highway Research Board will continue its work in this field.
2. A study of the amount, character, origin, destination, and purpose of traffic upon city streets that are extensions of the state primary road system.
3. A study of real estate values and earning capacity in the vicinity of through streets in cities as affected by street improvements.
4. A study of the effect of road improvements upon rural property values and earning power.

CONCLUSIONS

As a result of this study, the following conclusions have been drawn:

1. Motor vehicles should pay a "readiness to serve" charge.
2. Motor vehicle users should pay for the use of roads in proportion to the extent of their use.
3. Funds raised through special taxes upon motor vehicles or motor vehicle users should be employed only for highway improvement.
4. It is not possible, from the information at hand, to determine what proportion of road costs should be paid from user taxes. General practice concedes that the major part of the primary road costs shall be paid from motor vehicle license fees and taxes on gasoline.
5. The state should be the sole agency levying special taxes upon the motor vehicle or highway user.



HUME DAM, ACROSS THE MURRAY RIVER, AUSTRALIA

THE BRIDGE IN SERVICE

Longest Continuous Railroad Trusses Yet Constructed

New Bridge of the Chesapeake and Ohio Railway at Cincinnati

By WILSON T. BALLARD

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
VICE-PRESIDENT, THE J. E. GREINER COMPANY, BALTIMORE, MD.

IN ADDITION to the record-breaking length of its continuous span, this bridge over the Ohio River at Cincinnati has an anchorage pier of unusual design to resist a longitudinal force of 2,200 kips; a new concrete river pier cleverly incorporated with an old one of stone masonry to form one of the main river piers for both the old and new bridges; and a silicon steel superstructure weighing over 8,000 tons. It was erected without inconvenience to railroad traffic on the old bridge or to navigation on the river. The paper, which is here abstracted, was presented by Mr. Ballard on January 22, 1931, before the Construction Division of the Society at the Annual Meeting in New York.

DURING 1926, the Chesapeake and Ohio Railway Company commenced extensive improvements in Covington and Cincinnati. Among other projects, this work included replacement of the old Ohio River double-track bridge by a new double-track bridge designed for Cooper's E-70 live load. The construction of this new bridge across the river was justifiably included in the program of improvements because it would permit the railway company to operate its heaviest power between Covington and Cincinnati with resulting improved efficiency and economy in handling cross river traffic, instead of being limited, as it had been in the past, to the use of power approximately equivalent to Cooper's E-40 loading.

The recorded history of this important railroad crossing of the Ohio River begins with the paper of William H. Burr, M. Am. Soc. C.E., entitled "The River Spans of the Cincinnati and Covington Elevated Railway, Transfer and Bridge Company," which was published in Vol. 23 of TRANSACTIONS. This old double-track bridge, constructed from 1886 to 1888, provided the Chesapeake and Ohio Railway Company and the Louisville and Nashville Railroad Company an entrance to Cincinnati from the east and south.

As described in TRANSACTIONS, the bridge was designed for a railroad live load on each track consisting of two consolidation engines weighing 119,000 lb. each, exclusive of tender, followed by a uniform train load of 2,500 lb. per ft., and a highway live load on each wagonway and sidewalk of 60 lb. per sq. ft., the equivalent of 960 lb. per lin. ft. per truss. The floor system and the lateral and transverse systems of bracing were built of wrought iron; all main truss members were built of steel.

An inspection of this bridge, made during June 1916, by J. E. Greiner, M. Am. Soc. C.E., Consulting Engineer, found it carrying locomotives approximately 55 per cent heavier, and train loads 100 per cent heavier than those for which it was designed, with all operation of these loads over it limited by order to 15 miles per hour. In accordance with the recommendations made following inspection, it was strengthened in some of its members and continued to carry these loads safely for a period of 13 years, until March 1929, when the new bridge was put into service.

After having been maintained in service as a railroad bridge for a period of about 41 years, this bridge has now been converted into a highway bridge, and as such should continue in service indefinitely, or for as long a period as its owners take proper care of it.

CONDITIONS GOVERNING DESIGN OF NEW BRIDGE

The old bridge consists of three simple through-truss spans resting on stone masonry piers, the middle span being 550 ft. center to center of piers, and each side span 490 ft. center to center of piers. The river piers, one at each end of the 550-ft. span, rest on cribs of 12-in. by 12-in. pine timbers with interstices filled with concrete. These cribs, approximately 35 ft. high, were constructed on caissons built of pine timber with oak cutting edges and working chambers filled with concrete. Investigations revealed that this timber was sound and in good condition after more than 40 years of continuous submersion. Except for the need of pointing, the outer shell of masonry of the two river piers below the band course was in good condition. However, holes drilled into the bodies of the piers revealed that voids existed in the masonry backing behind the facing.

INVESTIGATING THE RIVER BED

Core borings made in the river along the bridge site indicated that, after passing through approximately 40 ft. of overburden consisting mostly of sand and gravel, a satisfactory and unyielding foundation of alternate thin laminations of hard shale and sandstone would be found at about 66 ft. below pool elevation, or about 54 ft. below low water. This corresponds with the recorded foundation depth of the original piers. Borings at the sites of both new shore piers indicated conditions requiring pile foundations. The site of the north shore pier lay on an old fill of cinders and miscellaneous material underlain by clay, sand, and gravel. At the bridge site, the river has a maximum variation of about 70 ft. between high and low stages.

Train movement by the Chesapeake and Ohio Railway Company and the Louisville and Nashville Railroad Company over the old bridge was almost continuous and it was desirable, if not absolutely necessary, that this should be maintained without interruption during the construction of the new bridge.

VARIOUS PLANS CONSIDERED

A number of different plans were considered. Some proposed extensions of existing piers and construction of the new bridge on them as close as possible to the old bridge, which should remain and be converted into a highway bridge; other plans, similar as to the piers, required the ultimate removal of the old bridge spans to make way for widening of the railroad bridge to four tracks, either with or without vehicular driveways and pedestrian sidewalks on brackets outside the trusses; still others contemplated span lengths greater than in the old bridge and the ultimate complete removal of it, including all piers except any that might be incorporated in the new work.

None of the plans contemplating the extension of both existing river piers could be adopted because the War Department refused permission to construct the bridge with a channel span the same as that of the old bridge, navigation interests arguing that in future it might be desirable to increase the channel opening by removal or alteration of the old bridge. Various plans with channel spans longer than those of the old bridge, and requiring construction of two new channel piers, proved either too costly or caused interruption to railroad traffic during their construction.

Finally, a plan was adopted which provided a 675-ft. channel span with 107.34-ft. vertical clearance above low water, or 37.14 ft. above high water, and side spans 450 ft. long between centers of bearings. This plan, Fig. 1, provided for the construction of the new bridge beside the old one, with the center line of its upstream truss 10 ft. from that of the old downstream truss, supported on a downstream extension of the old south river pier; a new river pier 125 ft. north of the old north channel pier; and new shore piers, the old bridge spans to remain and be converted into a highway bridge.

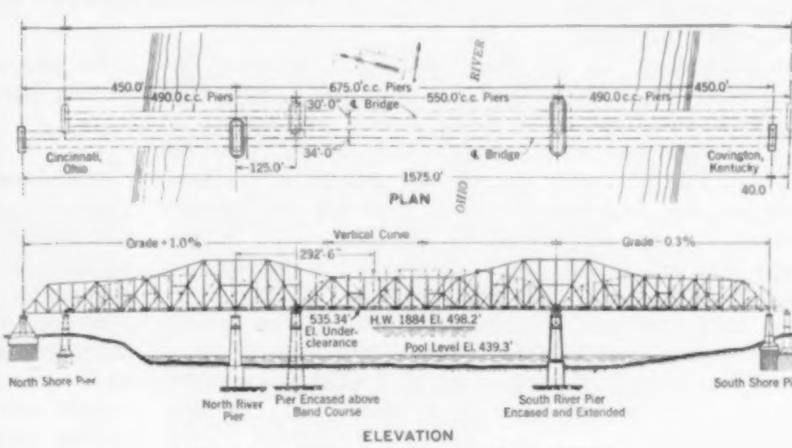


FIG. 1. GENERAL PLAN AND ELEVATION

The availability of unyielding foundations, the span lengths required, and the necessity for a bridge of maximum rigidity afforded an excellent opportunity for the economic use of a 1,575-ft. continuous truss bridge to rest on four piers. This type was adopted.

Adoption of this plan determined the locations of the piers. Exhaustive studies were made to determine whether to fix the long continuous bridge on one of the river piers and permit expansion to take place in both directions, or whether to place the fixed shoes at one end. The longitudinal force resulting from traction, to be resisted by the pier chosen to carry the fixed shoes, proved to be so large, 2,200,000 lb., that when applied to either of the tall river piers it caused bending stresses too great to be resisted by a pier stem of reasonable proportions and design, as the point of application of this force would have been 160 ft. above the foundation bed of either river pier. It was, therefore, decided to fasten the bridge to the north shore pier and provide roller shoes on the other three piers.

DESIGNING THE NORTH SHORE PIER

Owing to the great longitudinal force it must withstand, the north shore pier is of unusual shape and large size. It consists of a reinforced concrete footing 18 ft. thick, supporting reinforced concrete walls each 14 ft. 9 in. thick at the base, and triangular in side elevation, constructed under the location of each shoe, Fig. 2. The longitudinal center line of each wall coincides with the center line of the truss it supports. These walls are connected and braced laterally by means of a reinforced concrete cross wall extending from the base to a plane flush with the tops of the side walls.

This pier rests on 400 reinforced concrete piles, spaced 3 ft. center to center in each direction, driven through the old fill into the underlying original ground. Reinforced concrete tongue-and-groove sheet piling 8 in. thick was driven along the north and south sides of the foundation excavation and the footing was cast between the walls thus formed, which were intended to assist in preventing the possibility of any horizontal movement of the pier.

It was designed as a cantilever beam, considering it fixed at its base and resisting a force of 2,200,000 lb. applied 3 ft. 4 in. above its top—the elevation of the keys in the shoes—and acting in a line parallel to

the center line of the bridge, in addition to the vertical reaction of the north end of the bridge. The resultant of these forces was kept well within the middle third of the base, to prevent subjecting any of the piles to uplift. This pier contains 3,900 cu. yd. of concrete and 125,800 lb. of reinforcing steel.

SOUTH RIVER PIER PRESENTS PROBLEMS

The south shore pier is of usual design but the south river pier presents the most interesting features of design and construction encountered in the substructure of the bridge. It was necessary to combine a new concrete extension on a concrete foundation with an old stone masonry pier resting on a timber foundation, and the location of the steel superstructure is such that the downstream shoe of the new bridge rests on the new extension, while the old pier must carry a large part of the reaction from the new upstream shoe.

This design required the building of a 42-ft. reinforced concrete extension, on a concrete caisson foundation, to the downstream end of the old stone pier, and securing the new extension to the old pier. A photograph shows this work in progress. A concrete caisson constructed in a steel shell was sunk to rock foundation, elevation 374.3. The upstream end of this caisson in its final position was approximately 8 ft. from the downstream end of the crib supporting the old pier. After proper keys were cut in the rock foundation, the caisson was sealed and the working chamber was filled with concrete.

A steel sheet-pile cofferdam was then driven around both the old and new foundations and unwatered to permit grouting and encasement of the old pier and the construction of the concrete extension on the new caisson.

Prior to the encasement of the old pier stem, its entire surface was cleaned by sand blast, the joints of the masonry were pointed, and cement-sand grout was forced through holes under pressure into the entire downstream half of the stem to fill all voids in the interior. Only the downstream half was thus grouted as it was not considered that any of the load from the new bridge would be distributed to the upstream half.

Next, a 2-ft. reinforced concrete encasement was cast around the pier, concurrently with the construction of the stem of the extension, and the old pier and the mass of the new extension were firmly bound together by horizontal steel reinforcement embedded in the encasement of the old pier and in the new extension.

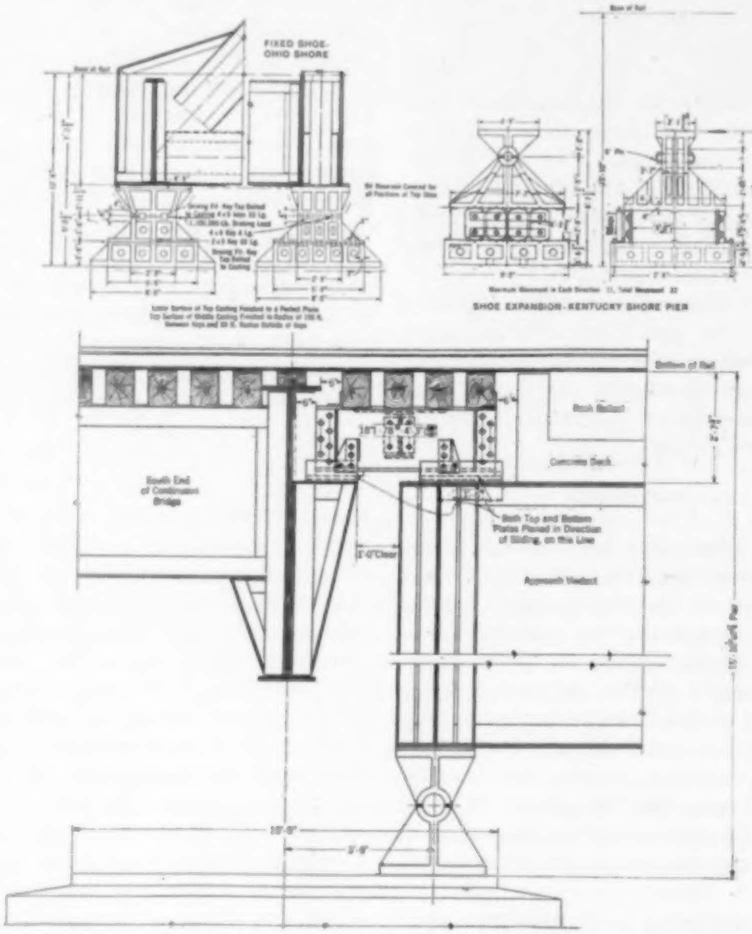


FIG. 2. FIXED SHOE OHIO SHORE PIER—EXPANSION SHOE, KENTUCKY SHORE PIER—DETAIL OF EXPANSION JOINT

The top stem of the old pier was not encased until after erection of the new superstructure was finished as it was necessary to remove the downstream end of the old top stem to make room for the upstream shoe of the new bridge. The removal of this portion of the masonry of the old pier involved a rather delicate operation in order not to endanger rail traffic on the old bridge, Fig. 2. The operation was safely accomplished by careful work in removing only as much of the old pier stem as was necessary to clear the new shoe. The masonry of the inshore and river faces of the old stem was left in place and served as buttresses against shearing off of the top edge of the old pier.

The North River pier consists of a reinforced concrete stem of usual rectangular cross section, with semi-cylindrical ends resting on a footing which was sunk in the form of a caisson.

DESIGNING THE CONTINUOUS SPAN

Numerous studies were made to determine the proper character and lines for the 1,575-ft. continuous truss. Considerations of appearance, as well as of economy, resulted in the selection of a triangular, or Warren type with sloping top chords and subdivided panels. Silicon alloy steel was used throughout at a basic working stress of 24,000 lb. per sq. in. for all steelwork, except rivets, which are of rivet steel. The resulting saving in steel weight was approximately 19 per cent over that of a similar structure built of structural grade steel at 18,000 lb. per sq. in.

Cooper's E-70 engine loading was used in computing the live-load stresses in the floor system, hangers, and sub-diagonals. The trusses were designed for 90 per cent of class E-70 engine loading, which, for the purpose of computing stresses, was represented by a load of 6,300 lb. per ft. of truss together with a load of 95,000 lb. concentrated at each of two panel points in each truss, separated by two panel lengths.

Erection stresses in no case governed the design of any member, although they were based upon cantilever erection of the middle span with no falsework between channel piers. This method of erection did not therefore necessitate the addition of any steel to that required in the finished structure for resisting dead, live, impact, and wind loads.

HEAVY SECONDARY STRESSES AVOIDED

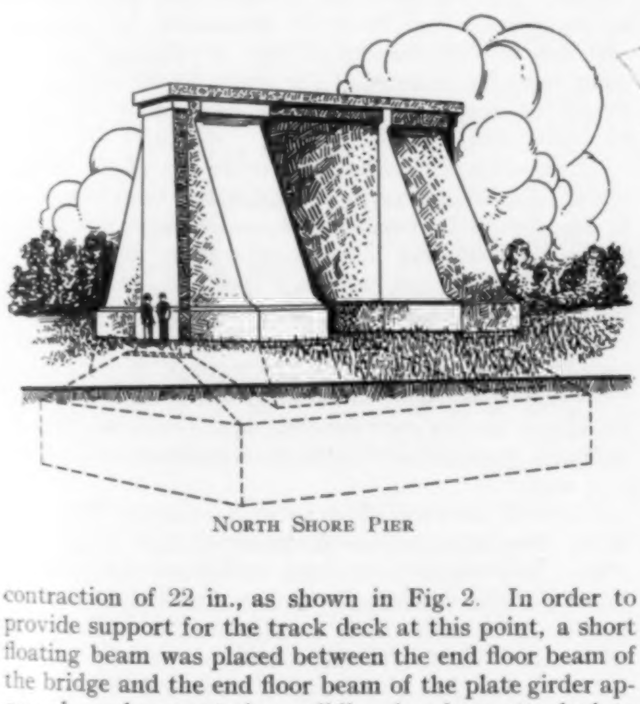
It is evident that, without special provision, the heaviest secondary stresses would occur in the bottom chords and inclined posts framing into the connections at the panel points over the channel piers. Secondary stresses in the bottom chords at these points were materially reduced by making the sub-verticals each side of these points $^1/_2$ in. shorter than the detailed length required for camber of the span and forcing the chords to connections with them, thus inducing initial stresses in the chords and sub-verticals that were relieved when the bridge was swung and under full load. The inclined posts were connected to the gusset plates by means of pins, thereby eliminating secondary stresses entirely from these members.

The bottom lateral system was designed as a continuous truss of three spans, and the top lateral system as simple spans between end hip connections and the upper ends of the inclined posts at the two channel piers.

To prevent corrosion of the rollers and bearing surfaces, and the accumulation of debris, steel boxes were constructed around the rollers and, upon completion of the bridge, were filled with an unadulterated petroleum-base cylinder oil. Approximately 1,600 gal. of oil were required to fill the six bearings.

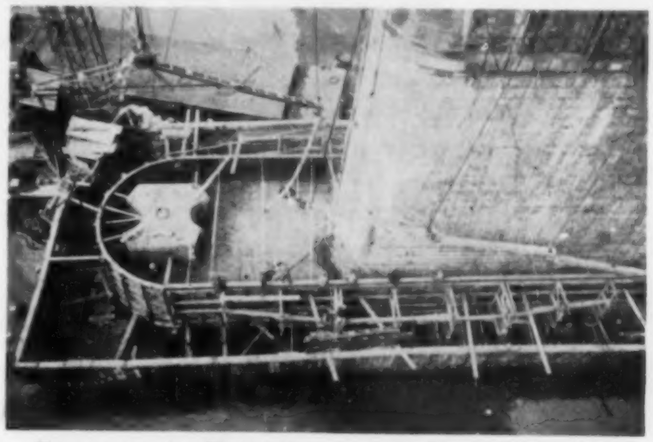
PROVIDING FOR EXPANSION

At the south end of the bridge, provision was made for maximum movement due to thermal expansion and



NORTH SHORE PIER

contraction of 22 in., as shown in Fig. 2. In order to provide support for the track deck at this point, a short floating beam was placed between the end floor beam of the bridge and the end floor beam of the plate girder approach, and supported on sliding bearings attached to each of these floor beams. These bearings were fitted with stop angles so as to permit 12 in. of movement of the floating beam on its seat at each end, thus providing for a total movement between the end of the main bridge and the plate-girder approach of 24 in. The floating beam



EXTENSION AND ENCASEMENT OF THE SOUTH RIVER PIER
Looking Down from the Bridge

carries four 8-in. by 12-in. cross ties, between which spacer blocks were placed, to prevent them from bunching. The track deck consists of 8-in. by 10-in. creosoted cross ties, 130-lb. T-rails, guard rails, and a plank walkway between tracks. The rails were laid continuous over the bridge and its approaches, with no special frog or other device at the south end to provide for expansion movement.

The side spans were erected on falsework constructed on piles driven in the river. The middle span was erected by cantilevering over both channel piers to closure at its center. The erection of both side spans was commenced and carried on simultaneously. In the early fall of 1928, serious anxiety was felt for the safety of the south side span since frequent high water had delayed the completion of the south channel pier. As a precaution, heavy timber piles were driven upstream of each bent of the falsework and the falsework was lashed to them by steel wire cables in such a manner as to moor it against the force of a flood and also to protect it to some extent from floating debris.

Construction of the substructure was begun in July 1927, and completed in October 1928. Work was often interrupted by abnormally frequent and prolonged periods of high water during the spring and summer of 1928. Erection of the steel was commenced June 1928, and the bridge was put in service in March 1929.

ACKNOWLEDGMENT

The United Gas Improvement Contracting Company of Philadelphia built the piers, and the American Bridge Company furnished and erected the steel superstructure. The bridge was designed by the J. E. Greiner Company, who served in a consulting capacity during the construction. It was built under the supervision of C. W. Johns, M. Am. Soc. C.E., and Crosby Miller, Assoc. M. Am. Soc. C.E., Chief Engineer and Bridge Engineer, respectively, of the Chesapeake and Ohio Railway Company, with G. G. Lancaster, M. Am. Soc. C.E., of the railway company, Resident Engineer.

HINTS THAT HELP

Today's Expedient—Tomorrow's Rule

The minutiae of every-day experience comprise a store of knowledge upon which we depend for growth as individuals and as a profession. This department, designed to contain practical or ingenious suggestions from young and old alike, should afford general pleasure not unmixed with profit.

A Highly Sensitive Device for Measuring Stresses and Deflections

By John Hedberg

Junior American Society of Civil Engineers
Instructor of Civil Engineering, Purdue University

The need for measuring stresses at points in the foundations and abutments of model dams, and arch deflections to the order of millionths of an inch, has led to the development of a very sensitive electrical measuring circuit at the Engineering Experimental Station of Purdue University. The measurement is accomplished by reading a galvanometer recording the fluctuations in the plate current of a vacuum tube caused by the changed capacity of manometer condensers in a resonant oscillating circuit. The diagram of the set-up is shown in Fig. 1, in which:

- A = storage battery
- B = B Battery (45 volts)
- C = C Battery (2 volts)
- D = variable condensers with micrometers
- G = galvanometer (L. and N., 1,021 megs sensitivity)
- H = honeycombed coils (1,000 turns each)
- K = oscillating circuit
- L = grid leak (2 meg ohms)
- M = manometer condenser
- S = 50,000-ohm variable shunt
- U = blocking condensers
- V = vacuum tube (X-201 A)
- X = choke coil (250 millihenries)

In short, stresses or deflections in a structure cause changes in the distance between the plates of the manometer, M, which is imbedded or fastened to the outside of the structure to be tested. These changes in separation cause changes in capacity which alter the frequency of the oscillating circuit, K, which, when in resonance with the grid circuit, L, through the coils, H, produces varying grid potentials that disturb the plate circuit through the galvanometer. The C Battery circuit and the shunt, S, control the sensitivity of the galvanometer.

The circuit is old and its sensitivity has been used somewhat, but as far as I know, its application to stress measurement in structures has never been tried before. As a scientific curiosity, it has been used by Prof. J. E. Brock, formerly of the Purdue Physics Department, who found that a manometer with air between the plates was capable of measuring accurately movements of 0.0000002 in., producing a straight line relationship between deflection and galvanometer reading. In order to use the circuit, I experimented with solid dielectrics between the plates to carry stresses across.

After rejecting a number of specimens, including rubber and paper, 57 condensers of 1-in. by 1/4-in. brass plates, separated by strips of white mica 1/64 in. thick, were imbedded in the mortar of a model arched dam and proved sensitive to stress changes of 0.1 lb. per sq. in. Although the testing of the dams is far from com-

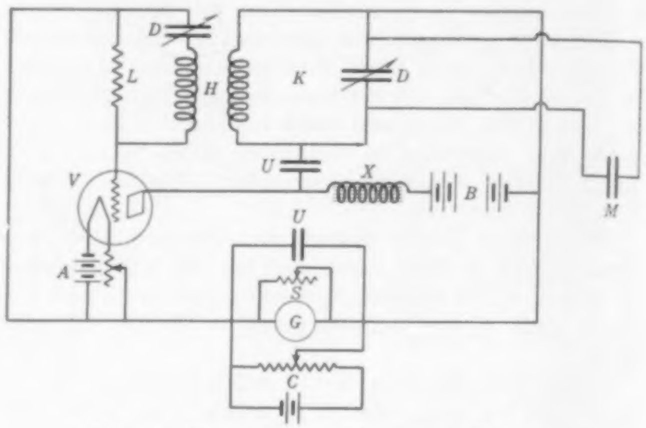


Fig. 1. Vacuum Tube Measuring Circuit

plete, the success of measurement by the electrical circuit is assured.

A number of precautions were found necessary in order to obtain good results. The oscillating circuit, being highly sensitive to changes of all sorts, must be shielded from stray currents by a metallic screen, preferably of copper. The reader of the galvanometer must stay as far away from the circuit as convenient, for close approaches or disturbances of any sort during measurement must be avoided. The leads to the manometer should be separated as far as convenient to avoid excessive capacity.

There are some limitations to the use of the instrument. No satisfactory manometer has been developed to measure both tension and compression alternately without introducing initial compression that is never completely removed, although positive and negative deflections in open air are readily determined. Repeated calibration of the manometer condensers appears necessary for consistent results. The changes in capacity of the condensers follow different laws for the rotation of the plates than for pure translation, so that it is necessary to insure translation if calibration has been carried out that way.

I secured the same effect by decreasing the dimension of the condenser in the direction of the variation of stress. For variation in both directions, it is possible to reduce the condensers to very small disks or even points. The manometer condensers introduce points of weakness in the structure which cannot be avoided, but probably this weakening effect is negligible in case of pure compression.

In spite of the numerous precautions and limitations of the measuring device, the writer believes that the ability of the instrument to measure over very small areas and through short lengths in the interior of structures may make it a very useful device for testing. Cheapness and portability seem to compensate to a large extent for the care and calibration difficulties during measurement. The applicability of the circuit to the measurement of oscillating stresses where changes are continuously photographed is a hopeful possibility that may soon be realized.

Bidding Security Desired for Construction Work

By Scott Keith

Member American Society of Civil Engineers
Assistant Engineer, Metcalf and Eddy, Engineers, Boston

It is customary on public construction work to require bidders to furnish with their bids a certified check, a cashier's check, government bonds, a bid bond, or some other form of security as a guaranty that, if awarded the contract, they will sign the agreement and furnish the desired surety bond within the time stated.

The amount of bidding security should be sufficient to repay to the municipality the difference between the total amount of the lowest acceptable bid and that of the next bid, plus the damage incurred by the delay in case of default by the lowest acceptable bidder. If all bids are rejected, the amount should be enough to pay the cost of re-advertising the work, plus the difference between the amount of the lowest acceptable bid under the re-advertised work and the amount of the original lowest acceptable bid, plus the damage incurred by the delay involved.

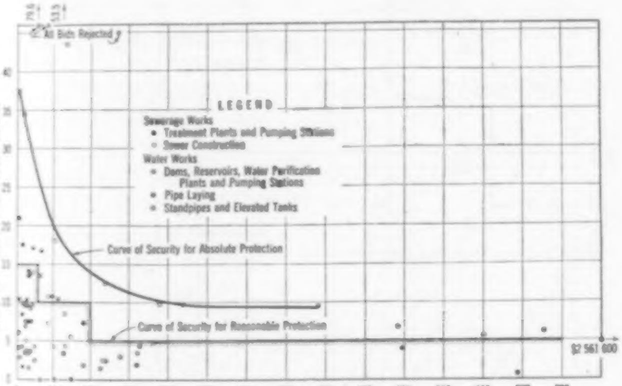


Fig. 1. Bidding Experience Indicates Amount of Bid Bond

Although there is no practicable means of establishing the amount of the damage caused by delay prior to the time that bids have been received, there still exists such a damage. Any figures made, therefore, to establish absolute bidding security without such allowance are bound to represent a figure that may be lower than the actual loss incurred.

The differences between the two lowest bids, expressed as a percentage of the lowest bid for some 60 or more municipal contracts involving sewerage works and water works, for which Metcalf and Eddy were engineers, have been plotted, as shown on the accompanying diagram, Fig. 1.

There have been cases where the lowest bid has been materially below the amount that was felt reasonable for the work involved and where the other bids have all been considerably higher than the lowest bid. Upon investigation of such cases it has been found that the bidder has either made a mistake in his bid, has overlooked some hazard involved in the work, or through inexperience in such work has made an unreasonable bid. Under these conditions it has been felt to be to the best interests of the municipality to reject the lowest bid and accept the next higher bid. Under these circumstances, the lowest bid has not been considered in the attached diagram, and only the "lowest acceptable bid" and the next higher bid have been used.

It is generally desirable to express the amount of the certified check or other bidding security as a definite amount, instead of a fixed percentage of the bid, because it enables the bidder to delay filling out the proposal form and permits him to make last minute alterations in the prices without changing the amount of the bidding security. Often the certified checks are not included with the bids but are given to some officer of the municipality prior to their public opening. If the checks are all of the same amount and not a certain percentage of the bid price, there is no opportunity for any knowledge of the bid price of some bidder to become known to any other persons.

It is apparent from examination of this diagram that the amount of bidding security for larger construction work need not be as high a percentage of the contract price as that required for work of smaller magnitude. Two curves have been drawn, one representing the percentage desired for "absolute protection" (not including loss caused by delay) and the other showing what is felt to be "reasonable protection."

There are certain advantages in having the same per cent of bidding security for work within certain limits of cost. We have adopted the practice of setting the certified check at 15 per cent of the estimated cost of construction for most work involving less than $30,000, 10 per cent for work between $30,000 and $100,000, and 5 per cent for all work involving over $100,000. These figures agree with those given in the curve marked "security desired for reasonable protection." The amount of the certified check should, of course, be taken at the nearest round figure. If two contracts were to be let, one at $90,000 and another at $125,000, the check for the smaller would be $9,000 and that for the larger would be $6,000 if this curve were followed. To eliminate such inconsistencies it would be desirable to fix the certified checks for both contracts at, say, 7 per cent of the estimated cost, that is, $6,000 and $8,000, respectively.

Data on which this paper is based represent contracts for both sewerage and water works let in the middle western and eastern part of this country. It is possible that bids on work in the South and Far West may give different results. It would be of general interest to compare results of studies in these localities.

An Unusual Framing Method

By H. S. WOODWARD
JUNIOR AMERICAN SOCIETY OF CIVIL ENGINEERS
PELHAM MANOR, N.Y.

In framing a floor, structural engineers often find themselves presented with a condition such as that shown in Fig. 1. When this occurs they at once reframe the area to get rid of this condition, both because it looks structurally unstable, and because it is not convenient to erect. However, occasionally it is convenient and economical to use this form of framing.

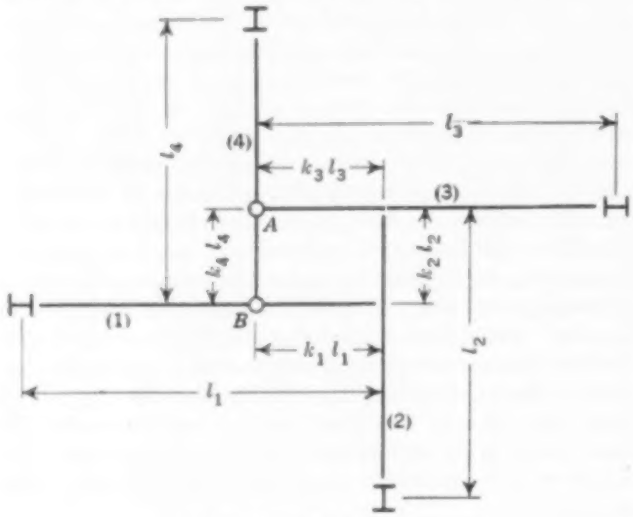
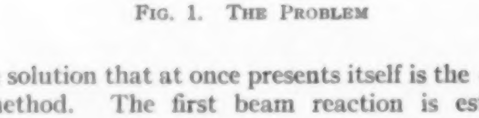


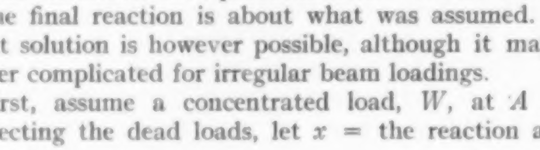
FIG. 1. THE PROBLEM

The solution that at once presents itself is the cut-and-try method. The first beam reaction is estimated; and the estimator then proceeds around the frame to see if the final reaction is about what was assumed. An exact solution is however possible, although it may be rather complicated for irregular beam loadings.

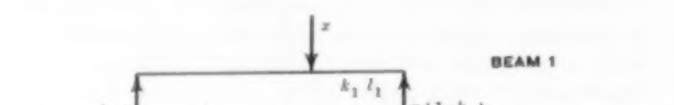
First, assume a concentrated load, W, at A and, neglecting the dead loads, let x = the reaction at B. Taking Beam 1, the reactions are:



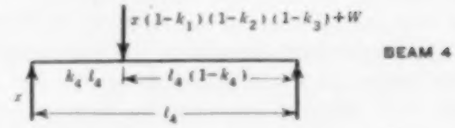
for Beam 2 they are:



for Beam 3, they are:



and, for Beam 4:



which is the starting point.

Taking moments around the right-hand end and solving for x:

$$x(1-K_1)(1-K_2)(1-K_3)l_4(1-K_4)+Wl_4(1-K_4) = xl_4$$

$$\text{or, } x = \frac{W(1-K_4)}{1-(1-K_1)(1-K_2)(1-K_3)(1-K_4)} \quad \ldots\ldots[1]$$

Instead of the concentrated load W, take a uniform load of W_1, W_2, W_3, and W_4 on Beams 1, 2, 3, and 4, respectively. Working around in the same manner as above, the following equation may be derived:

$$x = \frac{\frac{W_4}{2}+\frac{W_3}{2}(1-K_4)+\frac{W_2}{2}(1-K_3)(1-K_4)}{1-(1-K_1)(1-K_2)(1-K_3)(1-K_4)} + \frac{\frac{W_1}{2}(1-K_2)(1-K_3)(1-K_4)}{1-(1-K_1)(1-K_2)(1-K_3)(1-K_4)} \quad \ldots\ldots[2]$$

Note that in both of the above equations, for values of x, the denominator is the same. The numerator of the last equation shows that $\frac{W_4}{2}$, $\frac{W_3}{2}$, etc., are the reactions from each beam taken independently. Be sure the reaction is at the end which frames into the next beam and not into the column.

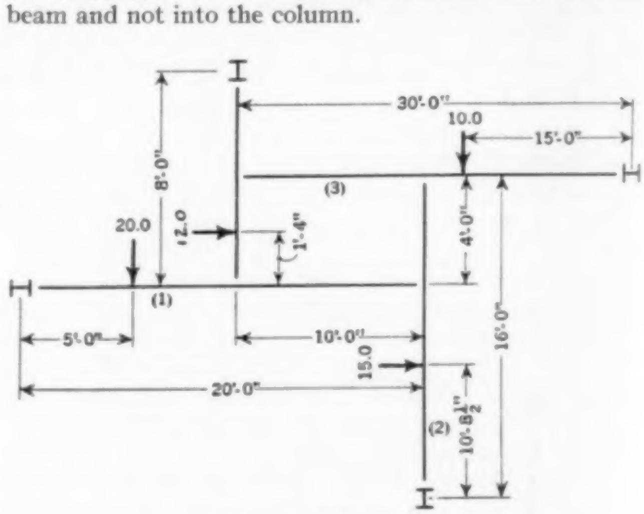


FIG. 2. A SOLUTION

For example, take the problem as shown in Fig. 2. Then $K_1 = {}^1/_2$, $K_2 = {}^1/_4$, $K_3 = {}^1/_3$, $K_4 = {}^1/_2$, and the loads as shown. In Equation 2, the reaction of the right-hand end of Beam 1 from the load of 20.0 is $5.0 = \frac{W_1}{2}$.

The reaction of Beam 2 = $10.0 = \frac{W_2}{2}$;

the reaction of Beam 3 = $5.0 = \frac{W_3}{2}$;

and the reaction of Beam 4 = $10.0 = \frac{W_4}{2}$.

Substituting in Equation 2, we derive $x = 19.5$. This may be easily proved by working around the frame with the same result.

These equations are derived merely to prove that the framing is sound and determinate. This method of framing works well where one of the beam reactions is close to a column, as shown in Fig. 3. In this case, the erection problem is not unusual because Beam 1 acts as a cantilever bracket until the other beams are in place. However, for ordinary problems, it will probably be easier in most cases to solve by the cut-and-try method, as a fairly close guess can be made the first time.

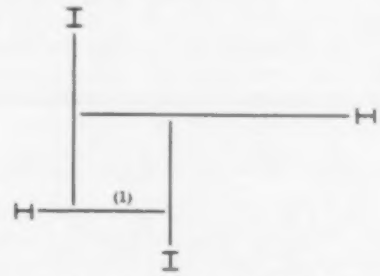


FIG. 3. AN APPLICATION

A Simplified Hydraulic Jump Formula

By KARL R. KENNISON

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
DESIGNING ENGINEER, METROPOLITAN DISTRICT WATER SUPPLY COMMISSION, BOSTON

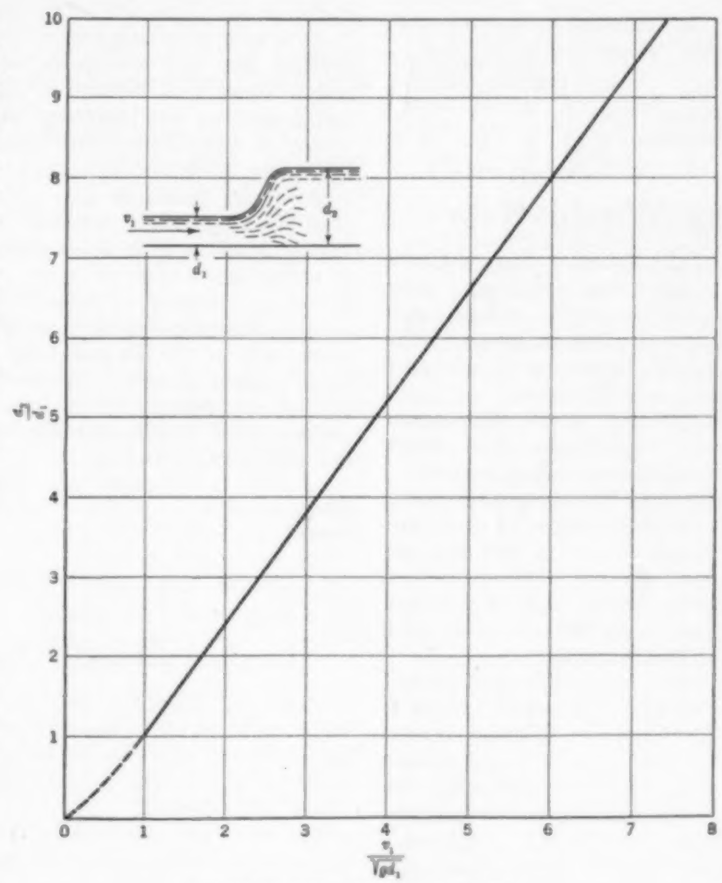
A SURPRISINGLY large number of mathematical relationships owe their complications to the fact that they must satisfy not only all the real values of their variables but also all values that might be called unreal or imaginary. This peculiar fact about some of our complicated formulas is not at all apparent until they are rearranged to make it evident. It is then possible to eliminate, or practically eliminate, the complication for purposes of ordinary use. Several hydraulic formulas are of this sort, for example, that for the hydraulic jump.

IMAGINARY OR UNREAL VALUES ELIMINATED

The equation that expresses the theoretically correct relation between the depth before the jump, d_1, the depth after the jump, d_2, and the velocity before the jump, v_1, in units of feet and seconds, in a rectangular channel, may be rearranged as follows:

$$\left(\frac{d_2}{d_1}\right)^2 + \left(\frac{d_2}{d_1}\right) = 2\left(\frac{v_1}{\sqrt{gd_1}}\right)^2$$

When this relationship is plotted graphically, as shown, it is evident that the curved portion of the line, that is, the portion which represents—or we might say requires—the complication of the formula, is entirely beyond the reach of real values, since it lies in that range where the ratio of depths after and before the jump is less than unity, and where the velocity before the jump is less than the necessary critical velocity to produce the jump.



SOLUTION OF HYDRAULIC JUMP
Dotted Part for Imaginary Values. Real Values Form Practically a Straight Line.

The rest of the line, or the useful part, is so nearly a straight line that its divergence from it can hardly be observed. The equation of this straight line is, therefore, for all practical purposes, the equation of the hydraulic jump. It is:

$$d_2 = \frac{v_1\sqrt{d_1}}{4} - 0.45d_1$$

In the design of flumes, chutes, overflow dams and similar hydraulic structures, consideration of the hydraulic jump has become of increasing importance. Technical publications have recently carried numerous theoretical discussions and practical applications.

A further exposition of the theory of the hydraulic jump, beyond that which may be easily found in a bibliography of the subject, was presented under another subject in TRANSACTIONS, Vol. 81, page 116.

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Engineering Knowledge Coordinated

The Editor: The question presented in Mr. Flinn's paper, in the October issue, regarding inaccessibility of knowledge is one that applies with equal force to practically all branches of the engineering profession.

Instances are continually coming to my attention in which the evidence of proper coordination of research work is conspicuous by its absence. On the other hand, there are instances where this has already been realized and steps taken to correct it. I have in mind, as an example, the conditions which led ultimately to the formation of the National Research Council. This, it will be recalled, was organized during the War for the special purpose of coordinating and concentrating all available information and directing the research activities of our country.

This group has been maintained ever since and may be the logical nucleus for finding the answer to Mr. Flinn's question. It has the organization and background of 12 years' service and should, under proper circumstances, be capable of expansion. It is suggested that groups interested in research of special importance to themselves should first affiliate and then contact with the National Research Council. I know of no better plan than this under present conditions.

Ely C. Hutchinson, M. Am. Soc. C.E.
Editor, "Power"

New York, N.Y.
January 23, 1931

Better Indexing Would Help

To the Editor: I note, in the October issue of Civil Engineering, Dr. Flinn raises the question, "How can all existing knowledge that should be utilized on a given project be made available to the engineer?" He discusses this problem principally in terms of scientific societies, research laboratories, and libraries.

There is another aspect to which I would like to call attention. The engineer who specializes in a given field receives publications, letters, and other sources of information which he is obliged to file away and which in the end become his most valuable reserve of material. Various filing systems have been devised which provide a place for every subject under the sun, but nothing is done to provide for the minute subdivision of a single topic except to state that there is an infinite number of decimal figures available for this purpose.

It would be of great benefit to the engineer if a competent body of men would formulate rules for filing such technical articles and express the rules in such general terms that they could be applied to any specialist's collection. For instance, if an article deals with the dielectric constant of rubber in rubber-covered wires, should it be filed under "dielectric constant," "rubber," or "wires?" A definite rule should ensure that the same thing is done every time so that different people using the file will always know where to look. A more general question is whether such data should be filed by topics alphabetically, or simply in order of receipt. Should there be an index, or should reliance be placed solely on the proper grouping of articles?

A great number of similar questions arise whenever one attempts to create a filing system. While a different answer might advantageously be given to any one of these questions under different circumstances, I believe that such advantage might be more than offset by that of uniformity. The cause which was advocated by Dr. Flinn would be greatly advanced by the formation of a committee of engineers to find a solution of this problem. Such a committee should include specialists from a wide range of fields so as to ensure the wide-spread usefulness of their report.

William A. Del Mar
Habirshaw Cable and Wire Corporation

Yonkers, N.Y.
January 23, 1931

A Research Medium Available

To the Editor: I have read Alfred D. Flinn's article on "Research Advances Civil Engineering," and feel that all engineers must share his concern for the wider distribution of scientific information.

As a practical suggestion, may I venture to say that further use and extension of the Engineering Index might meet this situation. A committee of which I am a member has just been in communication with the editor of the Engineering Index and also with the Engineering Societies' librarian, and from their explanation of the ideals of this publication, it seems to me that the long-sought medium of distribution of scientific information is already within our grasp. Perhaps it is unfortunate that only one of our national societies is, so far, interested financially in this project, which is now happily on a successful basis. Perhaps joint ownership of the Engineering Index might be the way to provide still wider distribution of scientific information, but certainly we do not want to set up another organization which has the same general purpose as the Engineering Index.

D. Robert Yarnall
Yarnall-Waring Company,
Chestnut Hill, Pa.

Chestnut Hill, Pa.
January 23, 1931

To Facilitate Library Research

Sir: Dr. Flinn's paper, in the October issue, naturally divides the subject into two parts: first, the inspiration for the individual or organization to take up research work; and second, simplification of such work when once begun.

Probably the easiest way to get such work started is to keep before those interested the fact that there is more or less information on the desired subjects somewhere available. Looking up such information and finding it not complete will be an incentive to look further.

The next point is where the information may be most easily had, and Dr. Flinn himself suggests that research work should begin and end in a library, which seems almost axiomatic. Unfortunately, libraries do not get their proper share of the money spent in research work; and if those interested in securing information could only be brought to realize this point, there would, in many cases, be saved large amounts uselessly squandered in duplicating work already done and recorded.

Library research work would be greatly facilitated and made much less expensive if more preliminary bibliographic work were organized. The bibliographies that now exist are not sufficient. The Engineering Index, in its present form, is an intelligent step in the right direction, and it is to be hoped that it will attract the support that will enable it to expand into a complete index of the literature. Another valuable tool for the research worker is the great card index of engineering which the Engineering Societies Library is preparing. In this index the work of bibliographic organizations all over the world is being combined in a single file and supplemented by the material collected by the library itself. This index has only been begun, but as it grows it will become increasingly valuable. Eventually it will save many hours now spent in laboriously examining dozens of scattered bibliographies.

Research workers need books and indexes. If proper funds for preparing these are provided, the more costly laboratory work can be reduced materially without any loss of results.

The final answer seems to lie in the dissemination of information, both as to what is now available and what is not available. This would include information regarding existing research laboratories, existing libraries, indexes, and bibliographies, and information as to the necessity of adding to the records by aiding those libraries and organizations that are now doing such good work.

Allen S. Miller
The Bartlett-Hayward Company

New York, N.Y.
January 5, 1931

Interdependent Researches

Dear Sir: Referring to Dr. Flinn's paper in the October issue of Civil Engineering, we all agree, I think, that from the standpoint of industry at large—in fact, from the standpoint of national well being—the scientific results of wisely directed and carefully performed research should be made generally available. Incidentally, as I understand it, our patent laws are aimed to facilitate precisely this comprehensive result.

The organization recognizing this duty benefits itself in that the very process of making research data available for the use of others involves the factor of added self-criticism. But what is of greater importance, the publication of such results brings out the criticism and experience of others; also, it may stimulate research leading to further advance and knowledge in that particular field. Broadly speaking, the industrial arts are now so closely interrelated and interdependent that an advance in knowledge which benefits one benefits all.

Edwin H. Colpitts
Assistant Vice-President,
American Telephone and Telegraph Company

New York, N.Y.
February 10, 1931

Research in Materials Needed

To the Editor: In the opening paragraph of his paper, "Research Advances Civil Engineering," in the October issue of Civil Engineering, Dr. Flinn raises an important question. That he does not vouchsafe an answer is disappointing, but not surprising. We in industrial chemical research ask with him, "How can all existing knowledge that should be utilized on a given project be quickly put into the hands of the man on the job. . . ?" Reading technical literature helps and must not be neglected. The trouble is that this yields a great many more general principles than it does detailed practical information. There remains the gulf between knowing how it is done and knowing how to do it, else why does development of a new product or process ordinarily cost many times more than the research, which, to the uninitiated, appears to have solved the problem?

To one primarily interested in substance rather than in form, however, there would appear to be no good reason why the engineer with his many problems of structure should be handicapped by needless uncertainty concerning his materials of construction. Here physics and chemistry must join hands, physics evaluating what chemistry produces, with research pointing the way to progress. Even if the very latest information on the improvement and standardization of structural materials, and on new materials produced by research, could be placed in the hands of the man on the job, it would not, of itself, build safe bridges and dams, but it ought to help the average engineer to get better results and the exceptional engineer to achieve great things.

L. V. Redman
Bakelite Corporation

Bloomfield, N.J.
January 24, 1931

Comments on Filtering Materials

Dear Sir: The progress report of the Committee on Filtering Materials, in the October issue provides the sanitary engineer with a needed and useful laboratory test that will aid in the selection of the most satisfactory material as a filter medium for sewage trickling filters. The results indicate that the standardized sodium sulfate test provides a reasonably rapid and severe soundness test for rock and gives uniform results at various laboratories, provided the recommended procedure is carefully followed. Much can be said in favor of fixing certain limits of variation in the temperature of the solution, and also, for fixing the temperature of saturation to at least five degrees over maximum solution temperature. Further consideration of the committee might well be given to the advisability of incorporating these additional controls into the technic of the soundness test.

It seems very desirable that these progress reports be made available to the sanitary engineering profession from time to time. This practice not only is of considerable aid in solving problems that are constantly occurring, but also offers an opportunity to apply the recommendations in a practical way. The results of routine use of the committee's recommended procedures should be made available to them, and, before the final completed report is issued certain valuable changes or refinements may be indicated as desirable.

The filtering medium is one of the most important factors in trickling-filter construction from the standpoint of

cost and operating results. The durability of this material influences vitally the future success of the trickling filter and its economical operation. Apparently, except in the unusual case, the medium used resolves itself into the selection of the most durable of several available materials. In the selection of the best material, quality tests are necessary for guidance of the engineer.

Although the problem is usually one of comparing and selecting the best material that can be secured locally from several available, it may frequently be advisable to compare a more remote and better grade of stone which, though more expensive for first cost, may prove more economical over a period of years. Further, it may be desirable to know the relative durability of the local rock to be used as compared to similar characteristics of more remote material, or material that has been in use over a considerable period of time. In these two cases standard durability tests and likewise better standardized methods of reporting results are convenient and of value.

In view of the fact that in some laboratories the freezing and thawing test has become standardized and costly apparatus has been provided for making this test cheaply and effectively, it is suggested that possibly a standard procedure for the test should be developed by the committee to guide engineers where circumstances or opinion favor the freezing and thawing test.

As indicated by the committee, more data on the relationship of filter size to loadings and more definite information concerning the various factors and their respective effects on the functioning of a trickling filter are of fundamental importance. So it would seem advisable that in the future the committee undertake the study of this extremely difficult as well as important problem. Although, with our present knowledge, the durability test of trickling-filter media is probably most important, other characteristics of the media may be of considerable importance when more fundamental information concerning the factors influencing the operation of trickling filters is obtained.

W. SCOTT JOHNSON, Assoc. M. Am. Soc. C.E.
Chief Engineer,
State Board of Health of Missouri

Jefferson City, Mo.
January 11, 1931

The Personnel on Building Projects

DEAR SIR: The matter of the personnel employed on various building projects often reveals a certain human selfishness. The order of naming the personnel obviously depends on the publication in which the account of a building project appears. The engineering and architectural publications emphasize the personnel that they are sponsoring.

A striking case appeared in the November issue of CIVIL ENGINEERING, in which the personnel of the Cleveland Union Terminal was named. The engineers were named first and then, apparently as a matter of professional consideration, an architectural firm of Chicago was mentioned. The lay reader would infer from this article that the entire project was planned and designed by engineers and that the duty of the architects was to decorate the building. The architectural publications stated that the same project was the work of the architects and made no mention of any engineers. The accounts of building projects appearing in professional publications no doubt seem humorous to those not in any of the building professions. The engineers and architects must be ignorant of the duties of each other, and it is suggested that they at least exchange and read each other's periodicals.

The architects seriously believe that building projects, other than bridges, dams, roads, sewers, and the like, are within their legitimate field and that engineers should be employed as assistants. The engineers, on the other hand, are contending that practically all building projects are within their legitimate field and that the architects are needed only to decorate the work. The dispute between the two professions does not create much concern when work is plentiful but, during periods of depression, each profession begins to covet the projects for which the other is best trained. The matter often reaches serious proportions, as in New York State where legislative measures have been enacted to protect the work of one or curb that of the other. The professions seem selfish and narrow in their interests and should cooperate rather than engage in disastrous conflicts.

CARL E. PAULSEN, Assoc. M. Am. Soc. C.E.
Architectural and Structural Engineer

Albany, N.Y.
January 17, 1931

What is a Project?

TO THE EDITOR: The query forming the title of this letter has been suggested by the frequency with which such expressions as "the cost of the project was," "the project will be completed in 1931," and the like, are seen. These suggest the question as to whether it is possible to construct or operate a "project."

Several of the best dictionaries have been consulted, without finding any authority for using the word project as synonymous with structure, works, or plant. The definition in Webster's *New International Dictionary* (*1930*) may be taken as typical. It is: "that which is projected or designed; something intended or designed; a scheme, design, plan."

Then the correct use of the word project is to designate a conception, idea, scheme, or plan, particularly in its embryonic stages; for instance, a project for a tunnel under the English Channel, or for a canal at Nicaragua. There seems to be some doubt whether a plan is still a "project" when definite designs have been made. It appears better to refer to "plans" or "designs" when such have been made, rather than to "projects."

There is no dictionary authority warranting reference to a dam, a sewerage system, a power plant, or works of any kind, as a "project." When the idea or plan has been translated into something tangible it has passed beyond the project stage and become an accomplishment.

Of course the English language is still developing, and new words as well as new meanings for old ones will enter it. Dictionary recognition must always follow after such development. It may be that in course of time the continued use of the word project in the sense of structure or system of works will result in its acceptance. It is to be hoped, however, that this will not prove to be so, since there is no need of employing the word project in such cases; moreover, the common usage fails to convey all the information which would be given by the use of the proper words. For instance, reference to the "Umatilla Project" would not indicate to a stranger that the works constituted an irrigation system rather than a railroad or a plant for sewage treatment.

No amount of misuse of words whose meaning is well established will ever make it good usage; "this data is" is no more likely ever to become accepted as correct than "I ain't gointer do it," common as both expressions are.

CHARLES W. SHERMAN, M. Am. Soc. C.E.
Metcalf and Eddy, Engineers

Boston, Mass.
January 1, 1931

More About the Great Wall of China

DEAR SIR: In the article by Emory W. Lane, in the October issue, he mentions numerous examples which illustrate his point that the Chinese of the past have initiated many new ideas in construction and in mechanical contrivances. A visit to China which gives only a superficial acquaintance with the problems with which the people are confronted, should result in a feeling of tolerance and sympathy, but if one remains long enough, and travels far enough, to learn of the great works which have been carried out in that country—many of them on a scale, and of an order of merit, surpassing anything of the same age in the Western World—the feeling of tolerance will develop into one of respect and admiration.

Regarding the Great Wall of China, so little has been written of this "greatest structure built by man," that a few additional details concerning it may be of interest to engineers. The length of the wall, according to Mr. Lane, is about 1,500 miles, or that usually given; but I. Newton Hayes, a lifetime resident of China, in his book, *The Great Wall of China*, places the total length, including loops and double lines, at 2,500 miles. This latter figure corresponds fairly closely with that given in the poetical Chinese name, the Wall of Ten Thousand Li. While Mr. Hayes' booklet obviously was not intended to serve as a technical reference, it contains good descriptions of many of the details of the wall and makes fascinating reading for anyone who is interested in the subject.

When one realizes that the Great Wall (with the exception of minor sections which were incorporated in the general plan) was built during the reign of the man who conceived it, it is easy to appreciate many of the legends which have been handed down concerning its construction. These tell of the heavy drafts made on the people for labor, of the hardships endured and lives lost, and of the thousands of bodies of exhausted laborers which were buried within the core of the wall.

ARTHUR M. SHAW, M. Am. Soc. C.E.
Consulting Engineer, National Construction Commission and Chekiang Provincial Government

Hangchow, China
January 11, 1931

The Engineer and Russia

TO THE EDITOR: When I spoke briefly before the members of the Society on January 21, at the Annual Meeting, it was my purpose to bring to their attention the great lack of authentic information which we have on the engineering opportunities in Soviet Russia.

We are privileged to live in a time when the engineering profession is coming into its own. Every activity of human life is so closely wrapped up in the work of the engineer that we begin to realize his importance. Unfortunately, our wealth in the technical world has so far outstripped our religious, social, and economic doctrines that we find ourselves in the midst of problems that are beyond our engineering skill. This is because our engineering activities have enlarged their scope to the extent that their effects are felt not only at home, but in far distant lands as well. Our recent developments in methods of communication and transportation have made us neighbors to those who live on the other side of the globe, and the interest of the engineer is particularly in the work of the pioneer, where most of the great feats are being done.

Before us is being opened a great panorama of engineering skill that the world has never seen before. What was formerly a backward country of over one hundred and fifty million population is now being brought into contact with the most modern developments in engineering in its most variegated ramifications. Many of our members will be credited with gigantic construction undertakings crowded within a short period of time—"five years" in the U.S.S.R. Engineering work stands as the greatest monument of peaceful arts and creation; and our Society, the great exponent of a great profession, should make itself felt in the land of reconstruction.

The Board of Direction has now authorized the appointment of a committee of three to make a careful study of the work in Russia. It should learn of the success or failure of the undertaking, acquaint itself, from the most reliable sources, with the conditions of life of American engineers in U.S.S.R., and give us a true picture of what is beyond the prejudice and misunderstanding which we spasmodically gather here and there. We want the truth.

The committee will make a great contribution to the Society by furnishing information, the lack of which, I believe, is keenly felt by many members. At least one member should personally go to Russia and verify the collected information by interviewing the American engineers, who are there, and by studying the engineering projects in the field.

GEORGE M. PURVER, M. Am. Soc. C.E.
Consulting Engineer

New York, N.Y.
February 2, 1931

Strength of Wire Rope

TO THE EDITOR: The articles on wire rope by B. R. Leffler and others in the November CIVIL ENGINEERING are interesting and instructive.

It appears to be fundamental and incontrovertible that the extreme fiber stress due to gradually bending a bar around a drum is given by

$$f = E\,\frac{d}{2}\,\Delta\frac{1}{\frac{D}{2}} \quad . \; . \; . \; . \; . \; . \; . \; . \; [1]$$

(in which $\Delta\frac{1}{\frac{D}{2}}$ equals the difference in curvature of the bar due to bending), so long as f does not exceed the proportional limit of the material. For a rope, R. W. Chapman has shown, in the October 1908 *Engineering Review* (London), that

$$\Delta\frac{1}{\frac{D}{2}} = \frac{2\cos^2 L\cos^2 B}{D} \quad . \; . \; . \; . \; . \; . \; [2]$$

It might be well to emphasize that the inclusion of $\cos^2 L\cos^2 B$ in Chapman's formula is not because the modulus of elasticity of the rope differs from that of the individual wires, but on account of the change in curvature.

The strength of a wire rope is approximately equal to 81 per cent of the strength of the sum of the individual strands. If L and B are each equal to 18 deg. and E = 28.5 × 10^6, Chapman's formula may be written

$$P \gtreqless a\left(0.81\, S - 23 \times 10^6 \frac{d}{D}\right. \quad . \quad . \quad . [3]$$

in which S should be not greater than the endurance limit of the individual wires, the sum of the areas of which is a.

Assume a 6 × 19 rope having the following characteristics:

$a = 0.46\,\phi^2$ (ϕ = diameter of the rope)

$d = \dfrac{\phi}{15}$

S = 110,000 lb./sq. in.

Then $$P \gtreqless \phi^2\left(41{,}000 - 705{,}000\frac{\phi}{D}\right) \quad . \quad . \quad . \quad . \quad . [4]$$

For 6 × 7 rope having the same characteristics, excepting that $d = \dfrac{\phi}{9}$,

$$P \gtreqless \phi^2\left(41{,}000 - 1{,}175{,}000\frac{\phi}{D}\right) . \quad . \quad . \quad . [5]$$

Formulas 3, 4, and 5 are applicable only to static loads. For moving loads, the effect of the acceleration should be given consideration. This may be done as follows:

In a mine hoist or similar apparatus,

Let P_1 = the static load

P_2 = increased tension in rope due to acceleration of "α" feet per second squared, in space "s" ft. and time of "t" seconds

λ_1 = stretch of the rope due to the static load P_1

λ_2 = stretch of the rope due to P_2

L = length of the rope between the load and the hoisting mechanism

E_r = modulus of elasticity of the rope

V = velocity

W_L = the kinetic energy of the load plus the work done by the static load P_1, moving through the distance $\lambda_1 + \lambda_2$

W_r = the work done by the rope, in resisting P_1 and P_2

Then

$$W_L = \frac{P_1}{32.2}\int_{s_1}^{s_2} \alpha ds + {}^1/_2\, P_1\,\lambda_1 + P_1\,\lambda_2$$

$$= W_r = \frac{1}{2}P_1\lambda_1 + \left(P_1 + \frac{P_2}{2}\right)\lambda_2 . \quad . \quad . \quad . [6]$$

From this it may be shown that, within the proportional limit,

$$P = P_1 \pm P_2 = P_1 \pm \frac{1}{5.67}\left(\frac{P_1 a E_r}{L}\,(V_1^2 - V_2^2)\right)^{1/2} \; [7]$$

This may be substituted for P in equations [3], [4], and [5]. The sign after P_1 in equation [7] is + when the load is being raised and − when the load is being lowered.

Since S is taken as the endurance limit, the load P may be considered as the ultimate strength of the rope for a protracted period and should be reduced by a suitable safety factor.

O. G. JULIAN, M. Am. Soc. C.E.
Catenary Engineer, Jackson and Moreland

Boston, Mass.
January 17, 1931

Commercial Traffic Develops Highway Plans

SIR: The term "highway transport," as used by Mr. Halsey, in his paper in the December issue, with reference to commercial automotive trucking as a problem, is well illustrated by a recent newspaper article stating: "Of the vehicles now in use, 23,316,013 are passenger cars, and 3,345,583 are trucks."

The ratio is approximately one truck out of every seven cars on the road, which should call for serious thought toward the present and future development of inter-city state highways primarily for motor transport purposes. Development of our national highway system has an important bearing on the location and growth of future industrial and manufacturing centers.

The design of a highway calls for a standard maximum width for trucks not to exceed 8 ft., thus permitting a standard 10-ft. lane. Improved hard shoulders are of great importance, as an accident preventive. A curbing and sidewalk should be provided on one side of the roadway in all cases where pedestrian travel prevails, as the hazard to the pedestrian increases in proportion to the increased speed of vehicular flow. Grade separation is to be encouraged to increase the efficiency of fluid flow, as the economic loss on heavily traveled highways from a cross flow is a problem which is attracting considerable attention.

Those who have come into contact with the Massachusetts State Code for traffic control signals have made favorable comment upon it. The code has accomplished a great deal toward the standardization of traffic signal installation and operation, and has eliminated unnecessary expenditures for applications where the volume of traffic was such that signals were not justified.

Commercial vehicle organizations should find Mr. Halsey's paper a stimulus to obtain state and national statistics on volume, routes, time, and seasonal fluctuation on inter-city highways. These statistics would provide material for engineering analysis and would further the justification of a 25-or 50-year coordinated state and national highway development program, whereby new projects would automatically be started at such time as predetermined volume capacities were reached on the present highways.

The highway system of the future should be of a national character, as to design and control, with the yearly publication of an arterial highway diagram by states, indicating average rate of speed, capacity, whether over or underpassed, and the class of road surface, together with contemplated projects.

GILBERT ROBINSON
Electrical Engineering Department, Edison Electric Illuminating Company

Boston, Mass.
January 14, 1931

Designing State Highway Systems

DEAR SIR: One of the important facts brought out by Mr. Cutler in the January issue is that the basis for designing a state highway system is something different and apart from that of designing some part of a road within that system. This thought should clarify a constantly occurring confusion in the discussions of state highway developments.

The routes of a state highway system are selected successively; generally, however, on other than a theo-

retical basis. Perhaps this will help us prevent the selection of illogical routes. It does seem that experience and knowledge of the state and its population will always be more of a ruling factor in these selections than any theoretical assumptions.

Highways connecting large centers of population, where the traffic census is known to be high, should be laid out for as direct routes and with as easy grades as possible. The question of measuring the economy of the state highway system becomes very pertinent when the traffic count reaches the point where a hard-surfaced road is demanded. Reduction in mileage and the resulting reduction in operating costs must always have consideration in the largely populated areas.

In the thinly populated regions, it is necessary to serve the major political subdivision of the state, that is, the county. By this, I mean that every county seat within the state should have a connection to a state highway system even although the population is so low that the traffic count would hardly seem to justify it, at least theoretically. These roads, therefore, quite naturally can serve their needs with a low-cost, low-type highway.

The effectiveness of any state system can be measured largely in terms of the population that it directly serves. However, the actual effectiveness of that highway system might be increased for long-distance travel if it did not so completely serve so high a percentage of the local population.

In discussing the method of financing, the most pertinent point is that the demand for adequate highways is not gradually growing upon us, but that it actually exists. There is only one answer to the rate of demand and that is to build highways under the bond issue system, whereby the roads are created, put in use and paid for over a period of years instead of being built over a long period of years and during that period having very unsatisfactory and uneconomical results available to the users.

I feel that Mr. Cutler's general discussion offers ample food for thought for those who are inclined to approach such questions from a theoretical standpoint. Doubtless, however, from his personal knowledge of the State of Missouri, he could lay out a system that would fit its needs as well as those selected by any theoretical assumptions. In other words, personal knowledge of the state is very essential to the design of a state highway system.

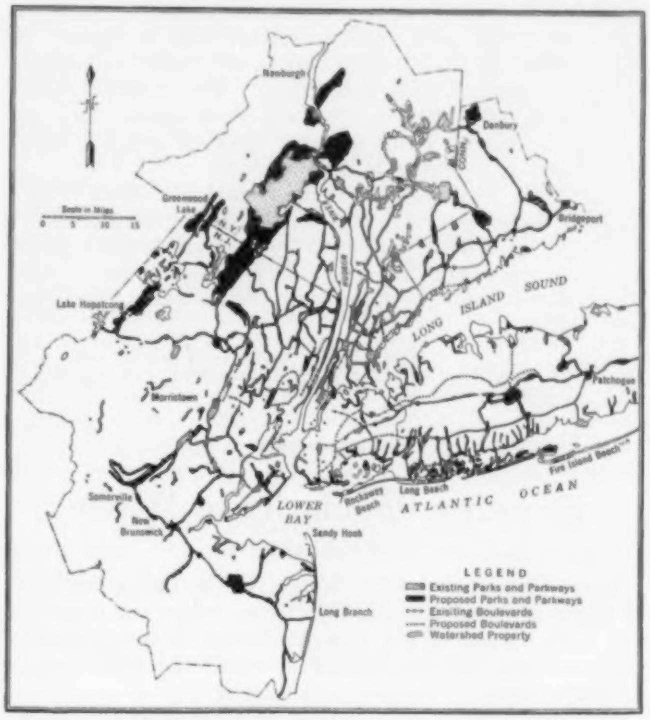
W. V. Buck, M. Am. Soc. C.E.
State Highway Engineer,
State Highway Commission

Topeka, Kans.
January 3, 1931

Dividends from Municipal Parks

Dear Sir: The papers by Mr. Stinchcomb and Mr. Horner, in the November and January numbers, are stimulating. There is no place where the payment of dividends by metropolitan parks has been greater than in the New York region. Fortunately, the realization of this fact is becoming general. The development of large recreational parks in the environs of New York City as shown on the map, was given its initial impetus by the creation of the Essex County Park Commission in 1895. The Palisades Interstate Park Commission, organized in 1900, was the result of joint action by the states of New York and New Jersey. Other active county park commissions are now functioning in Hudson, Westchester, Union, and Bergen counties.

That New York City is also awake to its own park problem is shown by the fact that in the five years following 1925, when the total park area, excluding parkways, was 10,025 acres, about 3,000 acres of additional parks, representing a 30 per cent increase, were acquired. Last year a special committee, under the chairmanship



Proposed Park and Parkway System for the New York Region from the Regional Plan of New York and Its Environs

of Comptroller Charles W. Berry, recommended the acquisition of an additional 3,893 acres, and a $25,000,000 bond issue was made available for that purpose.

The parkway, as developed in Westchester County, has emphasized the possibilities of utilizing park property for the rapid movement of passenger motor vehicles through pleasant and restricted surroundings. The Regional Plan of New York and its Environs has included a comprehensive system of such parkway routes, with boulevard connections where the acquisition of a wide parkway would not be practicable. Such routes will be used not only for so-called "pleasure" traffic, but also for passenger vehicles used in the transaction of daily business and for the movement of commuters between the city and suburban areas.

The New York region contains several examples of increases in real estate values resulting from large recreational parks. The Essex County Park Commission found that property adjoining their four parks in the City of Newark increased in valuation from 1905 to 1916, beyond what it would have been if the parks had not been constructed, by an amount sufficient to pay for all the parks in the county 2.4 times. During the three years before the creation of the Westchester Park system, the assessed valuations of real estate in the entire county increased from about $675,000,000 to $790,000,000 in 1923. In 1929 this figure had mounted to about $1,640,000,000, and it is claimed that much of the increase is directly attributable to the park pro-

gram. In Union County, N.J., the Park Commission found increases in assessed valuations adjoining Warinanco Park in Elizabeth, from 1922 to 1927, amounting to about $2,617,000 more than the computed normal increase.

The paper by Mr. Horner supports that of Mr. Stinchcomb in that it shows how water courses and adjoining property may become municipal assets by their utilization for parks and parkways. The surveys of the New York regional plan showed that there is a tendency in many municipalities to zone excessive areas for industrial purposes. The metropolitan region will be better off with more concentrated and more efficiently developed industrial centers and subcenters. This would enable the setting aside, for recreational reservations and adjoining residential areas, of many districts which are now considered as potential industrial sites.

The New York region offers several examples where natural water courses, still available for storm water drainage, have been paralleled by sanitary trunk sewers. These include the Bronx Valley Sewer, the Passaic Valley Sewer, and the joint outlet sewer along the Elizabeth River.

HAROLD M. LEWIS, M. Am. Soc. C.E.
Engineer of Regional Plan of New York

New York, N.Y.
January 31, 1931

Growing Popularity of Water Purification

SIR: The article by Mr. Weston in the December issue of CIVIL ENGINEERING, on purifying water for domestic use reminds one of the general change in water-quality requirements that has occurred within the past twenty or thirty years.

Originally, water purification was adopted to remove bacterial infection and, incidentally, extraneous material like silt and other suspended matter. Today the public demands a water not only hygienically safe, but clear, colorless, palatable, soft, and non-corrosive. The methods of securing water of these desirable characteristics are well outlined by Mr. Weston.

Irrespective of improved and more elaborate methods of water treatment, the present trend of water works practice appears to be toward securing supplies of as high a natural degree of purity as possible. After such supplies are obtained, the purification methods adopted are selected with the view of meeting the requirements of the prevailing conditions.

Furthermore, there is a tendency not only to secure a supply reasonably safe from the public health standpoint, but to surround such a supply with various additional safeguards in the way of purification as a factor of safety. The progress in the art of water supply sanitation has borne fruit in the marked reduction in the typhoid death rate in the United States.

E. SHERMAN CHASE, M. Am. Soc. C.E.
Metcalf and Eddy, Engineers

Boston, Mass.
January 23, 1931

Arc Welding Economies

SIR: In connection with Professor McKibben's article on arc welding, in the October issue, an interesting development may be noted in that a number of plants have found it economical to weld rather than to rivet. With improved methods, it appears that the future opens a very promising field for shop welding instead of riveting. In the photograph shown, all the trusses were shop welded by prominent fabricators.

It should not be overlooked that welding in the shop itself offers many economies in the elimination of connection angles and gusset plates, so that a considerable

SHOP WELDING OF TRUSSES SHOWS ECONOMIES

saving in steel is very frequently made. Only recently I had the opportunity of seeing the comparative designs of a riveted and welded girder for the same loading. In the riveted girder there were 69 pieces to assemble, with a total weight of 10,617 lb., while for the welded girder there were 35 pieces, with a total weight of 8,288 lb.

A. F. DAVIS,
Vice-President
The Lincoln Electric Company

Cleveland, Ohio
December 29, 1930

Handling Municipal Drainage

SIR: In his paper in the January issue, Mr. Horner has advanced a plan for taking care of municipal drainage which should challenge the careful study and thought of all engineers dealing with such work. It is also a very potent argument for adequate city planning, using the term in its broadest sense, as the carrying out of the plan suggested will be impossible without the cooperation of all city departments having anything to do with the laying out of streets, and the platting of new areas.

It will be equally, or perhaps more important to convince those engaged in real estate development that the scheme is not only desirable, but that it is financially practical. Fortunately, many of the larger real estate companies, especially those engaged in development of residential areas, have already adopted the idea of leaving the water courses more or less without encroachment. Beautification has probably been the greatest actuating motive in the modern high-class residential development.

In his suggested plan of handling municipal drainage, Mr. Horner seems to be entirely rational and sensible. The biggest obstacle seems to be that the engineer, worried with drainage troubles, is generally called in after the areas have been platted, and streets laid out, which is often too late to make the adoption of such a plan feasible. If it could be brought home to those initiating development of urban and suburban areas, that a

careful study of the drainage, both storm and sanitary, should be the very first step in development, a great deal of money could be saved and much more satisfactory results obtained. In a good many cities, the plan and zoning commissions have some control over this matter, but in practically every city the outstanding difficulty is the proper control of the development in suburban areas. Almost every city has examples of suburbs, the handling of which has made it practically impossible to carry out proper and satisfactory development.

The scheme proposed by Mr. Horner for handling the municipal drainage applies particularly to residential areas. In congested areas and high-value districts, heavy expenditures for drainage are often entirely justified. But there is no question that a great deal of money could be saved and a more pleasing city would result, if his plan were followed in areas where it is feasible.

Cases of considerable consequence frequently arise in drainage areas, where the addition of paved streets, sidewalks, driveways, and houses increases the storm run-off to such an extent that flood water leaves unsightly conditions along the water course, indicating that some control measures would be necessary. Such a situation as well as the balancing of land values against cost of drainage in congested and high value districts would have to be handled on their own merits.

The suggestion that roof drainage be allowed to enter sanitary sewers is perhaps subject to some question. Where sewage is disposed of by dilution, the question is, of course, only one of dollars and cents, but with disposal by treating plants it is an entirely different matter, as the by-passing of storm water, without affecting the operation of the plant, is not an easy matter.

N. T. Veatch, Jr., M. Am. Soc. C.E.
Black and Veatch, Consulting Engineers

Kansas City, Mo.
January 6, 1931

Obstacles to Municipal Water Purification

To the Editor: Mr. Wall's paper entitled "Developing the City's Water Supply," in the January issue, makes interesting reading. Considering its application to conditions at St. Louis, no criticism can be made of it; but as regards the general situation with respect to water supplies in the United States, exception may be taken to some of the remarks.

He states that various cities, principally on the Great Lakes, have "built filters to avoid . . . the danger that contamination might at any time extend beyond them (the intakes)." Of course the filters do not "avoid" the danger of contamination, but provide a line of defense against it. It might be inferred that Mr. Wall would favor taking water from the nearest source, no matter how badly it was contaminated. However, many people are averse to drinking water obtained from a badly contaminated source, no matter how thorough the treatment may be, and a great deal of bottled water is likely to be used in places dependent upon such a supply.

Moreover, there have been cases of interruption to the operation of filters and chlorinators, when unsafe water has been distributed to consumers, and in such cases the dangers are much less if the raw water is fairly good than if it is badly contaminated. It seems wise to obtain the best raw water which can be had at a reasonable expense, and then give it such treatment as may be necessary.

The statement that "chlorination is now regarded as necessary at all water works, to insure adequate freedom from bacteria," is too sweeping. There are many water works systems furnishing natural water of the highest degree of purity. Most of them are small, to be sure, and in the majority of cases they derive their supplies from the ground. As a rule, chlorination should be practiced as a safeguard, in all cases of surface water supply.

In his sweeping condemnation of private water companies, Mr. Wall also goes too far, in my opinion. There are, in all probability, proportionately as many municipal water departments, which are inefficiently or even dishonestly operated, as there are privately owned plants, which are either inefficient or charging excessive rates. Municipal water works, as a rule, pay ridiculously inadequate salaries to the men in responsible charge; and when adequate salaries are provided, the positions in many cases are so tempting to politicians that competent technical men have little chance.

Also, there have been many cases where it has required years to educate the electorate to the point of voting the necessary funds for urgently needed works of water supply or purification, whereas prompt action probably could have been obtained from the directors of a progressive water company. In principle, the public should own its water works; in practice, there are cases where better results can be obtained under private ownership.

Harrison P. Eddy, M. Am. Soc. C.E.
Metcalf and Eddy, Consulting Engineers

Boston, Mass.
January 20, 1931

Hazards of Cold Weather Construction

Sir: It is true, as Mr. Taylor states in the January issue of Civil Engineering, that winter construction has substantially increased during the past ten years, but the increase has been principally in the building industry. Engineering construction, outside the architectural field, so to speak, has had a twelve-month period for years.

In February 1903, during the building of a reinforced concrete bridge at Mishawaka, Ind., there was an ice floe of a half mile or more above the bridge, the ice being about 12 in. thick. The middle span of three was ready to pour when the thermometer dropped to ten below zero. All the materials were heated, the mix was made in a closed structure, and the concrete immediately covered with tar paper. Only 48 hours afterward, falling snow melted on the tar paper. Nineteen days after placing the concrete, the ice went out and took all the piling falsework with it. However, there was no damage to the span.

The Chicago Union Station program, carried along over a period of about 11 years, necessarily required twelve-month operation. All classes of work were made continuous, but it was necessary to train the contractors to it. During the first winter of 1915–1916, we were not, of course, doing much work, but it ran through the winter and afforded an opportunity of developing a proper program. It was necessary to help the contractor along as he had not planned for winter work. So we discovered a good deal about excess costs, but these were not serious compared to the advantages of completing a definite program.

A very curious incident happened in building a brick power house for a hydro-electric plant, one December in

northern Wisconsin. The building was diagonal with the points of the compass. The southwest and northeast faces supported the roof trusses and were in consequence tied. The other two faces had no ties.

The walls went up in cold weather, so the mortar must have frozen. At any rate, on Christmas Day it turned warm and the sun came out bright and strong, shining on those end walls. The next day it was discovered they had deflected from 4 to 6 in. toward the sun. The mortar on the sunny side had softened and the weight of the brick work depressed that side.

We had quite an argument, but what we finally did was to run tie rods between the walls to pull them to a vertical position; and they stayed put.

In any winter work—more particularly in the building industry—the extra costs must be balanced against interest charges of invested capital, and the early return of income from rentals or use.

Outside the building industry, contractors sometimes have a very large invested capital in plant and equipment, which "eats its head off" if it remains idle; so it is obligatory to keep this plant going. The problem, economic in all of its aspects, is not solved conclusively by weighing the financial element of cost versus return; but the politic side of keeping men continuously employed should be weighed and considered. Perhaps this lends the proper weight in balancing the scales.

A. J. HAMMOND, M. Am. Soc. C.E.
Consulting Engineer

Chicago, Ill.
January 2, 1931

Sewage Disposal by Sludge Digestion

DEAR SIR: The article by Mr. Hatton, in the October issue, entitled "Guiding Principles of the Activated Sludge Process," is a welcome statement. One cannot but be stimulated to give thought to such guiding principles from the viewpoint of the applicability of this process over a wider range of projects.

The major factor in such a consideration appears to be the handling and disposal of the sludge. While the engineers at Milwaukee were developing the processing of sludge to a dry, marketable product, other engineers and biochemists were making marked progress in the digestion of sludge in separate tanks or compartments generally mixed with fresh sludge from primary settling tanks. Success in sludge digestion has permitted the use of the activated sludge process in other projects, as at the North Side Works in Chicago; in Springfield Ill.; Elyria, Ohio; Peoria, Ill.; North Toronto, Ont.; and elsewhere. With these two processes for handling the sludge now generally available, an understanding of the guiding principles and the relative costs becomes important.

One of the most vital factors is the character of sewage to be handled. Some sewages are less amenable to treatment than others, as indicated by operating difficulties in the treatment of these sewages by the activated sludge process and in the differing amounts of air required, which largely influences the cost of operation. Thus, the relatively weak sewage treated at the North Side Works in Chicago requires only about 0.6 cu. ft. of air per gallon of sewage as compared to about 1.3 cu. ft. at Milwaukee, 1.3 at Indianapolis, and 1.8 at Pasadena. The differences are in part due to the different strengths of the sewages as measured by the oxygen demand; but there appear to be other influences arising from the character of the sewage which are not as yet fully comprehended.

The character of the sewage also influences the character of the sludge. The nitrogen content of the sludge from some sewages appears to be as low as 4 per cent, while in others it equals and occasionally exceeds the figures given for Milwaukee. In those plants in which the sludge is dried and sold, it is essential that its nitrogen content be kept up, and the operation of the process must be adjusted to this requirement.

Thus, to apply the guiding principles of the activated sludge process, as much consideration as possible should be given to the characteristics of the sewage to be handled and to the quality of the resulting sludge.

The process as a whole is closely related to the preliminary treatment of the sewage before aeration. Fine screening is used at Milwaukee and Pasadena, and relatively short sedimentation in some other projects. What bearing does each of these procedures have on over-all costs and on the selection of a process for disposing of the sludge?

These and other basic factors, such as the size and environment of the available sites, the amount of head, the need for pumping, the length of outfall sewers, and the like, are more or less closely involved in relative costs as regards different procedures in a given community.

In the total net annual cost of sewage treatment, the state of the market and the yearly average quality of the sludge have a bearing, so that results over a term of years are important. No operating costs are available on a similar large scale for activated sludge plants using sludge digestion. In several carefully prepared estimates, as for Grand Rapids, Minneapolis, and St. Paul, the writer has found the total annual cost to be about the same as at Milwaukee. With sludge digestion, the net annual cost of operation (including both purification and sludge disposal) will be higher than at Milwaukee and the fixed charges (at 7 per cent) will be less. With sludge dried and sold, the net operating cost under a favorable market will be less because of the income from the sludge; and the first cost, and hence the fixed charge, for a sludge digestion plant will be below that of a plant comprising sludge filters and driers.

The data given by Mr. Hatton indicate a construction cost for structures of around $90,000 per million gallons of rated capacity, of which some $50,000 appears to be chargeable to purification and $40,000 to sludge disposal. No direct comparison to the cost of a plant with sludge digestion can be made because of different local construction conditions and quantities of suspended matter. In general, with the purification part of the plant costing about the same, the works for sludge digestion should cost considerably less than works for drying and storing the sludge. Thus, there is indicated the possibility of accomplishing sewage disposal with sludge digestion at a lower investment cost and at no greater total annual cost than with sludge drying and marketing.

The work at Milwaukee has shown what can be accomplished where land areas for sludge disposal are not available within negotiable distance, and where other factors support the selection of the activated sludge process with sludge disposal by drying and selling. Mr. Hatton's article is a worthy description of so deserving an accomplishment.

SAMUEL A. GREELEY, M. Am. Soc. C.E.
Pearse, Greeley and Hansen,
Hydraulic and Sanitary Engineers

Chicago, Ill.
January 20, 1931

Testing Aggregates for Soundness

To the Editor: While the article by Dr. H. F. Kriege on "An Accelerated Soundness Test," in the November issue, covers very well the precautions to be observed in carrying out the sodium sulfate test for soundness, there are a few points upon which I would like to comment.

In testing fine aggregate, particularly concrete sands, it is the practice of our laboratory to separate a 500-gram sample into five or six sizes by means of standard Tyler screen scale sieves using the $^3/_8$-in., No. 4, 8, 14, 28, 48, and 100 sieves. The sample is washed through a No. 100 sieve, dried, and then separated into the above sizes. Each size is treated as a separate sample which, after testing, is thoroughly washed and screened over the sieve upon which it was retained. Microscopic examination is made of the material passing the 100-mesh sieve to determine if many undesirable minerals are present. Freezing and thawing tests on a duplicate 500-gram sample, separated into the same sizes, are run for purposes of comparison, unsoundness being determined by sieving as in the sodium sulfate soundness test. The 500-gram samples of fine aggregate are used because of the tendency of larger samples to clog the openings of the 8-in. diameter sieves. This tendency is particularly noticeable in tests on the finer sands.

A four-hour drying period at 105 deg. cent. has seldom been found sufficiently long to completely dry the sand samples. Often it is necessary to dry the samples for from eight to ten hours. However, the length of time in the drying oven may be considerably shortened by frequent stirring to allow the escape of entrapped moisture. In order to prevent loss during decantation and to facilitate handling, the samples are tied in muslin bags. These may be suspended in the oven for quicker drying, catching the drip in a tray. Also, the bags may be handled while drying, both to quicken the action and to prevent consolidation.

From the data now available, it is difficult to set limits for the amount of failure to be permitted in the sodium sulfate soundness test on concrete aggregate, since the quality of the concrete as well as that of the aggregate has an important bearing on the performance of concrete structures. Dr. Kriege suggests that 20 per cent loss in weight at 5 cycles be allowed. It would seem that this amount is too great for aggregates which are to be used in structures subjected to severe exposure.

We have considered that, until more information is available on the behavior of various types of concrete made with aggregates containing varying amounts of non-durable particles, the percentage of failure at 5 cycles should not be more than about 15 per cent in the case of coarse aggregates and not more than about 10 or 12 per cent in the case of fine aggregates. In fixing limits for specification purposes, two important factors that should be considered are the type of exposure to which the concrete will be subjected and the character of the unsound material. As regards the latter, our experience has shown that shales and similar thinly laminated materials and some cherts are the most dangerous and hence should be allowed only in small amounts. The service record of any aggregate should also be taken into account in passing final judgment on its suitability from the standpoint of soundness.

G. W. Ward
Geologist, Portland Cement Association

Chicago, Ill.
January 13, 1931

State Control an Aid to Sewage Works Operation

To the Editor: The abstract of the committee report on "Practical Operation of Sewage Works", in the November issue of Civil Engineering, states that the purpose of the report is to outline underlying principles necessary to insure the satisfactory operation of sewage works. A certain degree of standardization may be the ultimate result but the present goal is certainly satisfactory operation.

State control of sewage works operation, as provided for by law in Ohio, probably represents the best example that we have today. However, that state has a larger number of sewage works of sufficient size to require direct or advisory technical supervision of operation than has any other state. It is also true that the provision of adequate finances for operation has made considerable progress in Ohio.

Generally, lack of adequate statutory powers, of sufficient funds, and of properly qualified personnel by the health departments of many states has served to delay the organization of state control. Long continued municipal practices and political policies will combine to delay the attainment of ideal conditions for some years. Schools for sewage works operators serve their purpose to a certain extent, but in view of the widely varying capabilities of the small-works operator, can they be considered a real solution of the problem of satisfactory works operation?

A step in the right direction might be cooperation between the state department of health and the small municipality, by means of which the works operator would receive individual instruction in operation, record keeping, and simple laboratory tests at a larger works in the state where such instruction can be effectively given. This seems a means of expediting the attainment of satisfactory operation of the small works.

Provision of adequate operating funds and proper compensation for the sewage works superintendent usually lie with higher executives. This is also true concerning the publication of reports of works operation. This presents an opportunity for the state department of health to seek the cooperation of state legislatures and municipal authorities for the purpose of improving conditions pertaining to sewage works operation.

The committee has considered the various laboratory tests which seem essential to operation of different types of works. At present, laboratory control is quite generally confined to the larger works. Consideration might be given to a meeting of these works superintendents with the committee, the object being discussion and uniform adoption of certain basic tests according to the type of sewage works and the presentation of certain data in operation reports. The work of this meeting would be limited to these purposes, and no attempt would be made to discuss daily or monthly record standardization, additional records, and more extensive laboratory tests, all of which would be left to the judgment of the various works superintendents. I believe that such a meeting can be carried through to success and that a second step toward satisfactory sewage works operation will have been made.

Roy S. Lanphear
Supervising Chemist,
Sewer Department

Worcester, Mass.
January 22, 1931

Advancement in Survey Methods

TO THE EDITOR: The engineer, glancing back over the accomplishments of the past and comparing earlier methods and results with those of the present day, is apt to be astonished by the superiority of modern practice. Close application to the problems of the moment blinds him to the fact that the small improvements in methods made from day to day are of great importance when viewed in the aggregate. If the engineer doubts this, he need only read Major Bowie's paper on "Modernizing Triangulation Practice," in the December number of CIVIL ENGINEERING, to learn that this is the case as far as triangulation is concerned. The principles of triangulation have been known for many years, and no radical changes in methods have been made in the last three decades, yet the small improvements made from time to time during that period have increased the speed with which first-order triangulation stations can be occupied from less than 5 stations to 30 stations per month, according to the records of the U.S. Coast and Geodetic Survey.

Similar advancement would probably be noted if the records of mileage and the accuracy with which first-order levels are extended today were compared with records made 30 years ago. The progress which has been made in the small-scale mapping of the U.S. Geological Survey in 50 years' use of the plane table will be evident to any one who will inspect the maps made during that time. The gradual increase in accuracy of these maps has been due largely to increase of experience with the plane table and to the demand for better grades of work.

The advantage of applying photography to mapping has been recognized for many years, but until recently progress has been slow, due to the limitation imposed by photographs made from ground stations. With the development of the aeroplane and stereoscopic methods of determining differences of elevation from aerial photographs, a new impetus was received; and the progress since that time has been so rapid that the method has, in a few years, established itself and will undoubtedly continue to grow as its advantages are more generally appreciated. The next few years may witness a radical change in methods of mapping, due to the general adoption of new photographic methods and instruments only distantly related to the mapping instruments of the past.

T. P. PENDLETON, M. Am. Soc. C.E.
Chief Engineer,
Brock and Weymouth, Engineers

Philadelphia, Pa.
January 17, 1931

Proper Choice of Aerial Survey

SIR: There is a possibility that Mr. Dana's exceptional paper, in the January issue, may do more harm than good, because it unquestionably will greatly influence the judgment of many engineers who to date have not had experience in aerial photography. The methods and equipment described by Mr. Dana as well as the scales and type of photography which he selected for his work are decidedly different from the practice of other equally eminent transmission-line locating engineers, many of whom have repeatedly used aerial photographs for the same purpose.

It is seriously a question whether, as Mr. Dana states, his method is "capable of general use by engineers on work of this kind." Admittedly he had drawn this conclusion from the experience of this one survey only and unquestionably has been misled by it. From extended experience throughout this continent, I have been impressed with the fact that to efficiently use aerial photography it is imperative that different methods, different equipment, and more especially quite different scales and types of aerial photographic mosaics and maps are required in different territories. It has also been proved time and again that the method of using photography must be varied, covering different transmission-line location problems, even in the same general type of territories. Please note that I am referring to the efficient use of aerial photography. It is also true that almost any kind or type of aerial photographs is of enough service to be received favorably by the inexperienced.

It may surprise many locating engineers to know that a quite decidedly different type of aerial photographic map is required in Pennsylvania from that found suitable in the nearby state of New Jersey. In Texas and in certain parts of the Middle West, transmission-line engineers have found the cheap, contact-print, reconnaisance mosaic to be entirely adequate for their needs, but this same type of aerial photograph would be nearly useless to the engineer locating a transmission line and acquiring the necessary properties in or near Boston, Mass.

E. R. POLLEY, Assoc. M. Am. Soc. C.E.
Vice-President, Fairchild Aerial Surveys, Inc.

New York, N.Y.
January 23, 1931

Geodetic Surveying in Engineering Practice and Teaching

TO THE EDITOR: The article by Major Bowie, in the December issue of CIVIL ENGINEERING, is a brief description of the application of the engineering mind and engineering methods to an immense undertaking which is primarily of a scientific nature. To be sure, an ever increasing use is being made by engineers of the horizontal and vertical control, of geodetic triangulation stations, and of precise level bench marks. Yet it is probably true that the basic motive for the great geodetic work of the Coast Survey is scientific—the determination of the size and shape of the earth.

I wonder how many engineers and teachers dismiss it on the ground that it is so very exact, so involved theoretically, so scientific, that it has little use in solving, or little relationship to, the pressing problems of the practicing engineer, and that it therefore has no place in the courses of instruction offered in civil engineering colleges?

Clearly there is no justification for the inclusion of geodetic surveying in the civil engineering program as a means of preparing college graduates to secure positions with the U.S. Coast and Geodetic Survey. Indeed, Major Bowie has repeatedly stated that the survey prefers young men with special training in mathematics and physics rather than in engineering.

Something may, of course, be said from the "cultural" standpoint. It seems reasonable to give the young engineer something of practical astronomy and geodesy as part of a liberal engineering training. Those supposed to possess the elusive virtue of culture cannot define it, and contact with many college graduates shows that, assuming they have been exposed to it, the inoculation has not taken. In all probability, the best that the college or university can do is to stimulate an interest in cultural subjects—culture itself is an

achievement of the individual. If, therefore, the course in geodesy is given as a dry-as-dust exercise in complicated mathematical gymnastics, it had best be omitted. If given by a personality, it may possess great value.

A study of the relationship of plane and geodetic surveying in the past shows, however, another very important reason for including geodetic surveying in the program of engineering studies. We are prone to look upon geodetic surveying as ordinary surveying, elaborately complicated by ingenious individuals who are determined to make it completely useless. As a matter of fact, it is far more reasonable to consider plane surveying as a simplification of geodetic surveying, and it is historically true that progress in plane surveying has come primarily through the simplification and adaptation of geodetic methods to plane surveying practice.

In the past, the engineers transit, which has changed but little since its birth a hundred years ago, was a simplification of the theodolite; the engineer's level was a development from the geodetic instruments of the period of Abbe Picard; and the modern methods of coordinate computation in surveying, which replaced older inexact graphical methods, came from the domain of astronomy and navigation.

Surveying cannot remain static. It must improve and it is reasonable to assume, judging from the past, that current geodetic practice includes instruments and methods which will sooner or later become part of current plane surveying practice. Actual figures show that at the present time surveying organizations seldom number college graduates among their field forces—one or two such men may be employed as office managers or field superintendents. It is going to be a long pull toward an improved situation in plane surveying but we certainly can never hope for progress if engineers and engineering schools are going to be satisfied with following old methods instead of keeping constantly alert for possible improvements. Much of the progress in civil engineering must come through the problems and experiences of actual practice.

Yet it is also true that our engineering schools have a greater duty than merely training men in current technical practice and methods. It is clearly their fundamental duty to train men to carry on and improve engineering methods. Taught with this viewpoint, geodetic surveying becomes a basic and vital element in that part of the engineering curriculum devoted to instruction in surveying.

In Major Bowie's paper, it is shown clearly how the U.S. Coast and Geodetic Survey has reduced costs and increased output by adopting engineering principles in the planning and execution of their operations. It is to be hoped that it will also serve to stimulate interest in the possibilities of using some of the geodetic methods Major Bowie describes in engineering surveying practice.

J. K. Finch, M. Am. Soc. C.E.
Renwick Professor of Civil Engineering, Columbia University

New York, N.Y.
January 10, 1931

An Appeal for Surveying Precision

To the Editor: The paper on "Modernizing Triangulation Practice," written by Mr. Bowie, is a timely and valuable contribution to the literature of civil engineering. The majority of surveys made during the latter half of the past century were designed to meet the need or convenience of those who were extending lines of transportation or preparing the way for those who were to use or occupy lands. Field parties engaged in these surveys were generally far removed from organized society. Lands were cheap and, except for general instructions, much was left to the judgment of those in charge of operations. While the frontier was disappearing, real property values increased from the Atlantic to the Pacific and from the Canadian border to the Gulf.

Although competent civil engineers realized that surveys should be made with such care as to serve all needs, regardless of real property values, those who provided the funds for field work were very slow to recognize the economies that follow in the wake of accuracy. Those who have been in contact with modern development realize that accuracy is the prime essential, and that carelessness, or what often appear as convenient approximations, generally lead to financial loss.

The survey of the Atlantic Coast, beginning over a hundred years ago, introduced triangulation control into the United States. Through the U.S. Coast and Geodetic Survey, triangulation systems have been extended across the country, east and west, and north and south. It may be assumed that the responsibility of the Federal Government for this kind of service will terminate when monuments, established by triangulation methods, are to be found at distances not exceeding thirty to fifty miles.

During the past twenty years there has been a rapidly growing demand by cities for triangulation control. This has been sufficient to warrant the organization of engineering firms which specialize in control surveys for municipalities. Engineers engaged in local practice should take advantage of the results of this public service. Local control, like local government, must be supported by local people. Engineering firms engaged in the location, design, and construction of large undertakings, such as industrial plants, long bridges, and tunnels, should retain engineers who are qualified to determine accurately distance and direction preliminary to design, and then to make precise final location surveys.

The engineer who may consider himself a specialist, restricting his activities to design or construction, should be so familiar with the theory and practice of modern triangulation control that he may be satisfied that the distances and directions reported to him in connection with preliminary and final surveys are sufficiently reliable to completely support the work for which he may be held responsible. The training of the civil engineer should be balanced. His great responsibilities relate to location, design, and construction. Mr. Bowie's paper reminds us that modern triangulation methods involve no more specialization than is required in design and construction. He and others, who are frequently asked to recommend men qualified to participate in control surveys, realize the scarcity of talent of this sort. Surveys of the future are to be more exacting than those of the present. There are more men now engaged in surveys of all kinds than at any time in the history of the country. The specifications under which they work are more exacting than they were at any time in the past. Mr. Bowie reminds engineering firms and engineers generally that control surveys furnish the critical data governing design, final location, and construction.

Clarence T. Johnston, M. Am. Soc. C.E.
Professor of Geodesy and Surveying, University of Michigan

Ann Arbor, Mich.
January 2, 1931

SOCIETY AFFAIRS

Official and Semi-Official

Anatomy of the Society at Work

Most engineers appreciate a diagram more than a description. For them as well as others the chart on this page, showing the various functioning parts of a far-reaching machine, has been prepared. This gives in graphic form the present organization of the Society. The By-Laws having been amended by the Board of Direction at its meeting in January 1931, the changes are reflected in this new organization chart. It will be recalled that when the Functional Expansion Program was adopted, in January 1930, a chart of Society organization conforming to that plan was published in PROCEEDINGS for March 1930. The present chart, therefore, shows the new set-up of the various active units of the Society.

Annually, the *Year Book* is sent to each member of the Society, early in the month of April. This volume fairly bulges with explicit information about the Society and its activities, but it is a fair question whether many members peruse it very closely. It is hoped that this graphic presentation may win the attention of more of the membership and possibly act as an appetizer arousing a desire to learn more concerning the Society's activities.

It may be well to point out some of the differences between the present chart and the one published just a year ago. Perhaps the most important change is the addition of a tenth Technical Division, Engineering-Economics and Finance. The petition for the formation of this Division was presented at the Annual Meeting in January and approved by the Board.

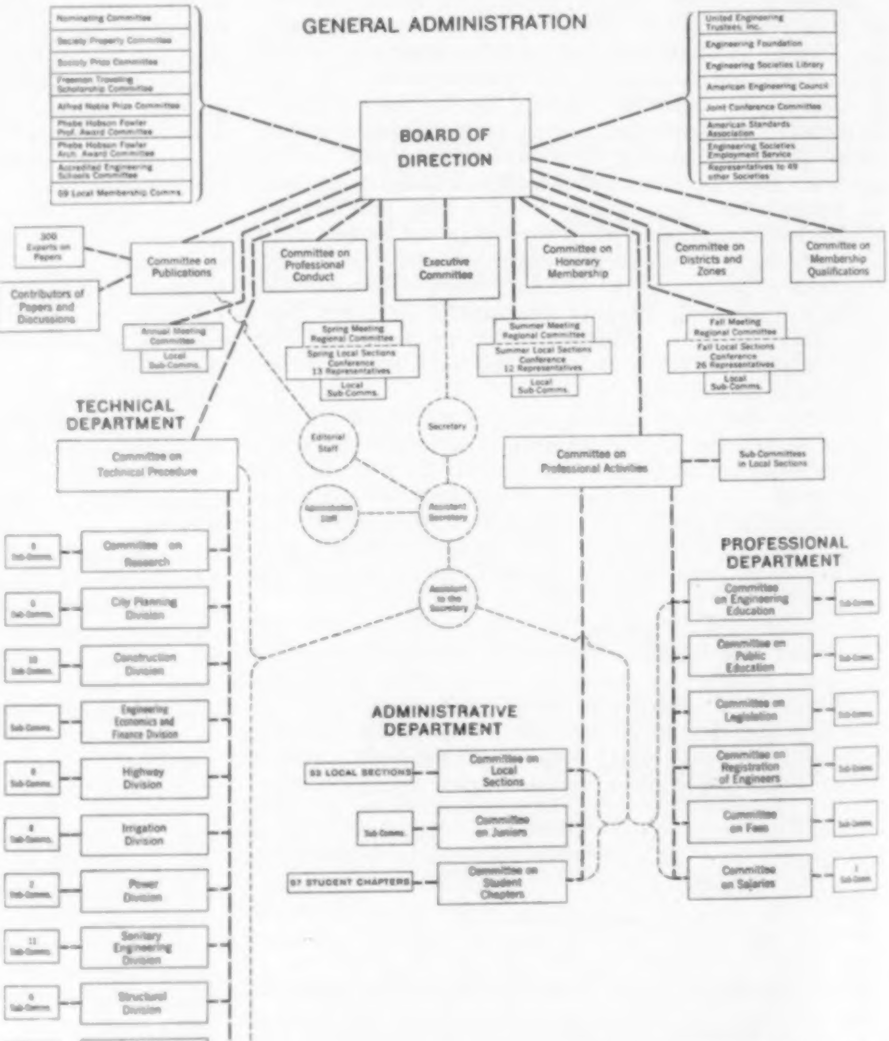
The Committee on Membership Qualifications has been transferred from the Administrative Department back to the Board of Direction. It had been originally planned to utilize the advisory services of non-Board members on this committee. Later judgment indicates that the function of this committee should be held rather closely by the Board itself, and accordingly the Board's own membership committee has been designated as the Committee on Membership Qualifications.

During the past year the Functional Expansion Program Committee has been charged with launching the plans of the professional and administrative committees and associated activities. Although created as a temporary committee, its present and potential values are such that it has now been placed on a permanent basis and its name changed to Committee on Professional Activities. As will be noted on the chart, it holds a position somewhat analogous to that of the Committee on Technical Procedure, although there is a striking difference in its personnel. The Committee on Professional Activities is composed of the President and Secretary, and nine Directors, each of whom is the contact member of an administrative or professional committee. It will be recalled that the Committee on Technical Procedure is composed of the President and Secretary, two Directors, the chairmen of the Technical Divisions, the chairman of the Committee on Publications, and the chairman of the Committee on Research.

In the upper right-hand corner there will be noticed the designations of United Engineering Trustees, Inc., and Engineering Foundation. These names were adopted during the past year, following a previous change which did not prove sufficiently descriptive in all respects.

A greater degree of prominence in the chart, as befitting their place in Society activities, has been given to the Local Sections and Student Chapters. A unified system of naming Society committees has been adopted and a number of minor changes have been made, indicating the number of sub-committees. It has also been decided to drop the "number of persons engaged" which appeared on the former 1930 chart.

As an experiment, each member might like to examine this diagram to find his own connection with Society work. He may be represented more than once—for example, in one of the Technical Divisions as well as in a local membership committee. If he is not there at all, the chart merely represents his opportunity of partaking in official activities. Practically all the duties represented are voluntary, the contributions of a faithful membership to a worthwhile and going organization.



AMERICAN SOCIETY OF CIVIL ENGINEERS
Diagrammatic Presentation of
SOCIETY ORGANIZATION
January 1931

Inaugural Address of President Francis Lee Stuart

Before a large group of engineers who attended the Seventy-eighth Annual Meeting of the Society in New York, retiring President Coleman called for the president-elect, Francis Lee Stuart, to be escorted to the rostrum. An impressive group of Past-Presidents and Honorary Members of the Society occupied seats on the platform. After Mr. Stuart had been inducted into office with an appropriate ceremony, he presented to Past-President Coleman the gavel he had used throughout the year—silver banded and engraved—as a visible evidence of the esteem in which he has been held during his term of office.

In his address, printed below, Mr. Stuart stressed the duty of the engineer to give liberally of his talents for the upbuilding of our country's prosperity.

"To the honorary members, past officers, and all members of the American Society of Civil Engineers and their families:

"I appreciate the honor and the opportunity for service to the American Society of Civil Engineers which your vote today has given me, and I recognize the responsibility which goes with my election as president.

"Our presidents, heretofore, have addressed the Society only at the Annual Conventions held in summer, but I wish to take this opportunity to express to the Society at large some of the thoughts which are in my mind on this particular occasion, as to the engineer's relation to his fellow man and to present conditions.

"I am proud of the engineering profession—proud of what it has done, is doing, and will do toward improving living conditions and bringing prosperity to our people. Because of these very accomplishments and the present unstable conditions, there is an evident necessity for us to take a more leading part in world affairs and by broader and more unselfish planning stimulate our potential mental capacities to make a still greater contribution toward stabilizing and continuously advancing the welfare of all the people.

"As to present conditions, we in this country are passing through a critical period. Individual reward for initiative and energetic effort has made our country great. This very incentive has been rewarded by such continued prosperity that the herd instinct and avarice of men have run wild without judgment and greatly aggravated world conditions and brought on us all an unwarranted period of strain and stress.

"Unemployment of all classes runs into hundreds of thousands in various parts of the country and the Federal Government, state agencies, and industry are jointly trying to meet that situation; and the engineers of the country, as you know, are daily doing their very important part in such efforts in the whole-hearted and creditable way we have a right to expect.

"We must all share the burden for letting things get awry. The fact is that this depression exists, is world-wide, affects us one and all, and calls for unusual effort by the members of our profession. There is an exceptional opportunity for great service and it is this professional phase which I want to talk about, for I believe it opens up a new era to engineers, if we have the foresight and energy to grasp it.

"As a profession, our objectives are broad but we have evaded the proper study of many of the needs of men. We should give the same quality of thought to matters of public policy and human interest that we have given to technical matters and materials and thus make our judgment and advice more helpful in the councils of men.

"The first requisite is that we, as individual members of our profession, engineers young and old, must be more than able scientists, more than able inventors, more than able designers, and more than able constructors. We must do our part in the formulation of the policies upon which our happiness depends. We must broaden our outlook, be better citizens, be more adaptable, be more aggressive, take more interest in the country's daily problems. By thoughtful endeavor we must mould and strengthen the efforts of our profession and increase our usefulness to neighborhood, state, and country.

"To emphasize the relationship of man to man, should we not say to our young colleagues that they, as engineers, are engaged in the most important branch of those arts of applying the sciences to the improvement of our living conditions; and that, as they themselves have been given the opportunity of studying and benefiting from the experiences of their predecessors in their chosen work, they, in return, should feel an obligation to dedicate a part of their lives to the benefit of mankind and give of their time and talents to the state?

"To those of our colleagues who, in the prime of manhood, have reached a place in their careers where their training and experience enable them to contribute to our store of knowledge should we not say that they should still further increase this store by research work, recording the results of their efforts for the benefit of posterity, and thus make their contribution to the future welfare of the world?

"And should not each of us say to himself that he owes to his profession and to his country a duty to be eager for public service and for greater usefulness and, with resolute cooperation, to take a serious part in the solution of the many problems that beset us all?

"If we can infuse these definitions and objectives into our ideals they will be great stimuli to our technical aspirations and enable us individually to become of increasing benefit to the profession and our own civic life.

"Let us not hold these things lightly; no effort is too great, no result too small. If we are to carry out such broad ideals we must re-educate outselves—we must prepare ourselves for additional hard work, worry, and sacrifice. And if we will persist in spite of rebuffs and disappointments, to try to live up to these ideals, we shall be building an almost irresistible force for good, which will enable us to reach far into the fundamentals of business and into the controls of country-wide, and even world-wide efforts, and enable us to exert a real force in shaping the social, business, and political conceptions of our time and to avoid a recurrence of the existing chaotic conditions in the future.

"I wish I could pass along to you some of the enthusiasm I feel for our profession after years of constant work. I have had the usual successes and failures, the usual accomplished and unfinished projects, and the usual pleasures and disappointments, but my years of quiet activity have passed without a boring moment as far as my profession is concerned and I have refused to be drawn away from the creative pleasures it affords.

"Even so, I have always felt that, while technical and creative work is a major phase of the engineer's usefulness, it was not enough, and that, in addition to contributing technical knowledge to help promote our prosperity, we should direct more of our individual energies toward taking our place with the forces which decide the ways and means and the uses to be made of our material progress.

"This requires us to take a more commanding share in the deliberations or controls of the economic, financial and managerial energies which influence our efforts, or are influenced by our initiative, and help to plan a better scheme of world control of supply and demand and a better understanding of cause and effect than exists today and so avoid a recurrence of such periods of depression as we now have.

"We will also have to do our part in solving the greatest problem of our age, which is to determine the direction in which living conditions shall be improved and how such progress shall be stabilized and distributed in an equitable way to satisfy human wants as these improvements are brought about. The advances in civilization prove that we can be helpful and I feel that, if the members of our profession will direct the trend of their thoughts toward this problem, their intelligence and training will have an influence for good and be of measurable assistance to humanity.

"There is still another duty to ourselves. From all sides, economical, social, and spiritual, present conditions warn us that it is important that we cooperate with all aidful agencies to make a proper technical, a proper laboratory, and a proper scientific study of the greatest of all raw materials, man—man as an individual and man in the mass—and that we cooperate to counteract his weaknesses when found, and make him an ambitious, energetic, helpful, and happy aid in the work of the world.

"One word more, please keep in mind for today and for the tomorrows which are to come, that the American Society of Civil Engineers is a great force and a great instrument for service and it requires our continuous working support and personal interest in its efforts in our behalf to keep it so. Therefore let us all determine to coordinate our efforts and keep the Society growing greater and greater.

"In our collective relations, we should be historians as well as a part of the history of our age. By precept and example we should

urge all engineers to help each other by taking their places in technical societies, by becoming working members in their programs to advance and to help the profession, by recording their findings and by doing their part in the many collective efforts of those societies.

"Technical societies' records are our great collective contribution to coming generations. Such societies, with universities and libraries in a broader sense, have been forming, developing, and recording for posterity the educational thoughts and forces which have been advancing our civilization.

"These educational agencies have kept currently available our knowledge of engineering which has prepared the way and enabled us and other engineers to make the advances in the art of living which will cause the present hundred years to be known in history as the 'Engineering Age.'

"The world at large, and even we ourselves, have just begun to realize the growing importance of our professional place in the scheme of life as it is today. I believe that the influence of engineering in the history of this age is so great that we can rightfully feel elation and encouragement as we move forward to meet the responsibilities of the future."

Secretary's Abstract of Executive Committee Meeting

On December 15, 1930, the Executive Committee met at Society Headquarters with President J. F. Coleman in the chair. Present were: George T. Seabury, Secretary; Otis E. Hovey, Treasurer; and Messrs. Bush, Dougherty, Eddy, and Winsor.

Approval of Minutes

The minutes of the meeting of the Committee held on August 11, 1930, were approved as adopted by the Board.

Change in Name of "Engineering Foundation, Inc." to "United Engineering Trustees, Inc."

Approval was given to the change in name of "Engineering Foundation, Inc." to "United Engineering Trustees, Inc."

The Engineers Water-Power Policy Committee

The proposal that there be formed, by American Engineering Council, and Engineers Water-Power Policy Committee, to be composed of two representatives from Council; one from the American Society of Mechanical Engineers; one from the American Institute of Electrical Engineers; and one from this Society, was approved with the understanding that there would be no financial obligation involved.

International Exposition for Housing and Town Planning

An invitation to the Society to participate in the International Exposition for Housing and Town Planning to be held in Berlin, Germany, from May 9 to August 9, 1931, under the auspices of the German Building Exposition, Berlin, 1931, was referred to the Executive Committee of the City Planning Division with the request that it investigate and report to the Board, with recommendations including the suggestion of delegates, if it finds that to be advisable.

Joint Committee on Standard Specifications for Concrete and Reinforced Concrete

Approval was given to the proposal that the number of constituent organizations represented on the Joint Committee on Concrete and Reinforced Concrete be increased to include five representatives from each of the following: Associated General Contractors of America, The American Institute of Architects, and The American Association of State Highway Officials.

Proposed Budget for 1931

The Budget for 1931 was prepared for presentation to the Board of Direction at its meeting in January, and many other routine matters of Society business were considered and acted upon.

Meeting of the Outgoing Board of Direction—Secretary's Abstract

On January 19 and 20, 1931, the Board met at Society Headquarters, with President J. F. Coleman in the chair; and present George T. Seabury, Secretary; Otis E. Hovey, Treasurer; and Messrs. Budd, Bush, Dougherty, Dusenbury, Dyer, Eddy, Gowdy, Hammond, Howe, Jacobs, Johnston, Knowles, Lupfer, Marston, Morris, Nicholson, Pirnie, Reichmann, Singstad, Slattery, Stevens, Thomas, and Winsor.

Annual Report of the Board of Direction

The annual report of the Board of Direction was presented and adopted.

Approval of Minutes of Board

The minutes of the meeting of the Board of Direction held on September 29 and 30, 1930, were approved.

Approval of Minutes of Executive Committee

The minutes of the meeting of the Executive Committee held on December 15, 1930, were approved, and the actions outlined therein were adopted as the action of the Board.

Committee on Meteorological Records of Weather Bureau

A committee to be composed of not less than five members from various portions of the United States was authorized, to report to the Board on methods of making the Weather Bureau of greater value to engineers engaged in all forms of hydraulic work. An appropriation of $500 was made for the work of this committee.

Districts and Zones

The boundaries of Districts and Zones, as approved by the Board at its meeting in July 1930, were adopted.

Appointment of Roy C. Gowdy as Director Confirmed

In consequence of the amendment to the Constitution providing for 19 Directors, and the consummation of all legal matters incident thereto, the appointment in July 1930 of Roy Cotsworth Gowdy, as Director for the newly created District 16, was confirmed.

Committee on Engineering Education

The Committee on Engineering Education reported on a number of educational matters under discussion. A resolution regarding a proposed requirement of Ph.D. degrees for professors in engineering schools was adopted as follows:

"Adequate professional training in actual engineering practice is essential, in addition to university training, as part of the qualifications of engineering teachers, and is entitled to due recognition. While approving the continuing development now under way of graduate work in engineering leading to advanced degrees, including the Ph.D. degree, attempts by any college or university association to demand Ph.D. degrees in general branches as part of the requirements for the engineering professors in accredited colleges is disapproved."

Committee on Accredited Schools

Upon the recommendation of the Committee on Accredited Schools, the Newark College of Engineering was approved as an engineering school of recognized standing. Also upon the recommendation of the committee, the rules defining recognized schools were changed and there was added the provision that recognition shall be predicated upon the satisfactory outcome of a visit to the school making application for recognition.

Committee on Student Chapters

The formation of Student Chapters at Harvard University and Michigan College of Mining and Technology was approved.

Engineering-Economics and Finance Division

In response to a petition with 66 signatures, a new Technical Division, to be known as the "Engineering-Economics and Finance Division," was authorized.

Local Section in Panama Authorized

A Local Section in Panama, to be made up of members of all grades who are residents of the Isthmus of Panama, including the Canal Zone, was approved and $60 was appropriated to the new Section.

Alabama Section Authorized.

The formation of an Alabama Local Section was approved, and $60 was appropriated to the new Section.

Committee on Publications

The Committee on Publications presented a report reviewing its work for the year, outlining the major objectives in the Society's publication program, and recommending that the Committee on

THE 1930 BOARD OF DIRECTION OF THE SOCIETY

From the paneled mahogany wall of the Board Room at Society Headquarters, a portrait of Alfred Noble, Past-President of the Society, calmly regards the final effort of the 1930 Board to close the year's business on January 19, 1931, just prior to the Annual Meeting of the Society. Beginning at the left of the near corner of the Board table, and proceeding around it, in a clockwise direction, those present are:

(1) *Harrison P. Eddy, Director, District 2*
(2) *Edward P. Lupfer, Director, District 3*
(3) *J. Houstoun Johnston, Director, District 10*
(4) *Frank L. Nicholson, Director, District 5*
(5) *A. F. Reichmann, Director, District 8*
(6) *Frank E. Winsor, Vice-President, Zone I*
(7) *Charles H. Stevens, Director, District 4*
(8) *Lincoln Bush, Past-President*
(9) *Joseph Jacobs, Director, District 12*
(10) *A. J. Hammond, Vice-President, Zone III*
(11) *Ralph Budd, Director, District 7*
(12) *Roy C. Gowdy, Director, New District 16*
(13) *Arthur J. Dyer, Vice-President, Zone II*
(14) *Allan T. Dusenbury, Director, District 15*
(15) *Ole Singstad, Director, District 1*
(16) *Morris Knowles, Director, District 6*
(17) *John R. Slattery, Director, District 1*
(18) *R. E. Dougherty, Director, District 1*
(19) *Malcolm Pirnie, Director, District 1*
(20) *J. M. Howe, Vice-President, Zone IV*
(21) *Carolina Crook, Secretary to Mr. Seabury*
(22) *George T. Seabury, Secretary*
(23) *J. F. Coleman, President*
(24) *Anson Marston, Past-President*
(25) *Clyde T. Morris, Director, District 9*
(26) *Franklin Thomas, Director, District 11*

Absent: D. A. MacCrea, Director, District 14 and Frederick H. Fowler, Director, District 13.

Technical Procedure aid in limiting manuals to concise, authoritative pronouncements of general interest and marked value not readily available elsewhere, and that all such material pass through the stages of presentation, discussion, approval, and adoption, laid down by the Board.

Amendments to By-Laws

Proposed amendments to Articles I, II, IV, V, and VII of the By-Laws, submitted earlier and referred to committees, were reported on, discussed, and adopted, and will be printed in the *Year Book* for 1931.

Professional Conduct

The Committee on Professional Conduct reported on six matters, which were acted upon by the Board.

Committee on Public Education

The report of the Committee on Public Education, which was approved, subject to such limitations as may be imposed on the program because of finances, recommended extension of the lantern slide lectures for the use of Student Chapters into similar lectures for use before the public; introduction of radio broadcasting to acquaint the public with important civil engineering undertakings; the use of short syndicated articles on subjects of general engineering interest; the preparation of a bibliography of motion picture films on engineering subjects; the appointment by Local Sections of committees on public education to act as clearing houses on local engineering news and also to furnish information to the Society's committee.

Committee on Legislation

On the recommendation of the Committee on Legislation it was decided that the opinion of the Local Sections be obtained on the segregation of the Water Resources Branch of the U.S. Geological Survey as an independent bureau; also that American Engineering Council be asked to supply information on the present status of lien laws.

Committee on Registration of Engineers

On the recommendation of the Committee on Registration of Engineers, that committee was instructed to proceed with: (1) the submission to other engineering organizations of certain proposed revisions of the Uniform Registration Law; (2) the formulation of a plan whereby special committees in every state, appointed by the Local Sections, will investigate and supervise all legislation, within that state, affecting the practice of professional engineers; (3) the initiation of an inquiry of the National Council of State Boards of Engineering Examiners, and other engineering organizations, to determine the advisability of establishing a National Bureau of Engineering Registration.

Proposed Budget for 1931

The proposed budget for 1931, as recommended by the Executive Committee, was approved after discussion in detail.

Resolutions Regarding Deceased Officers

To record sorrow at the recent loss of a number of eminent former Society officers, suitable resolutions were adopted in regard to the following: Gustave Maurice Braune, who died November 26, 1930; William Cain, who died December 7, 1930; Edward Carlos Carter, who died December 23, 1930; and Harry Hawgood, who died January 3, 1931.

Meeting of the Incoming Board of Direction—Secretary's Abstract

The Board of Direction met at the Headquarters of the Society, January 22, 1931, with President Francis Lee Stuart in the chair; and present George T. Seabury, Secretary; Otis E. Hovey, Treasurer; and Messrs. Buck, Chester, Coleman, Dusenbury, Gowdy, Herrmann, Holleran, Howe, Jacobs, Lupfer, Mead, Mendenhall, Morris, Morse, Reichmann, Singstad, Slattery, Stevens, Thomas, Waite, and Winsor.

Engineering Conditions in U.S.S.R.

Carrying forward the thought proposed at the Annual Meeting of the Society, a committee was authorized to make inquiry relative to the conditions surrounding the employment of engineers in the Union of Socialistic Soviet Republics.

National Hydraulic Laboratory

Past-President John R. Freeman addressed the Board regarding the National Hydraulic Laboratory, for which Congress has appropriated $350,000.

The following resolution was adopted:

"WHEREAS, the members of the civil engineering profession in the United States are profoundly interested in the National Hydraulic Laboratory recently authorized by Congress, and

"WHEREAS, the American Society of Civil Engineers desires to offer its assistance to the Secretary of Commerce, and to the Director of the Bureau of Standards, to the end that in the design of this laboratory provision shall be made for adequate facilities in order to provide opportunity for those researches which are fundamental to the design of large hydraulic structures and are inherent in large hydraulic problems,

"*Therefore be it resolved:* That the Board of Direction at its meeting at Society Headquarters in New York City on January 22, 1931, authorizes that a committee of five, of which the President of the Society shall be one, be appointed to render such service as it may in order that the National Hydraulic Laboratory of the United States may be so designed and developed that it will be fully adapted to the study of the problems which the tremendous natural resources and great industrial progress of this country must of necessity bring to it for solution."

Budget for 1931

The proposed budget for 1931, recommended by the outgoing Board, was considered and adopted.

Special Committees

The following personnel for committees for 1931 was approved, the President being given authority to complete it and to fill vacancies where necessary.

EXECUTIVE COMMITTEE: Francis Lee Stuart, Chairman; Charles A. Mead, Vice-Chairman; J. F. Coleman, John N. Chester, and F. E. Winsor.

COMMITTEE ON HONORARY MEMBERSHIP: Francis Lee Stuart, Chairman; J. N. Chester, J. F. Coleman, J. M. Howe, Anson Marston, Henry M. Waite, and F. E. Winsor.

COMMITTEE ON DISTRICTS AND ZONES: Joseph Jacobs, Chairman; D. A. MacCrea, and John R. Slattery.

COMMITTEE ON PROFESSIONAL CONDUCT: F. L. Nicholson, Chairman; Ralph Budd, J. F. Coleman, Anson Marston, and Franklin Thomas.

COMMITTEE ON PUBLICATIONS: Charles H. Stevens, Chairman; Henry R. Buck, L. G. Holleran, Edward P. Lupfer, and Ole Singstad.

COMMITTEE ON MEMBERSHIP QUALIFICATIONS: F. E. Winsor, Chairman; Allan T. Dusenbury, D. A. MacCrea, A. F. Reichmann, and Franklin Thomas.

COMMITTEE ON RESEARCH: Clyde T. Morris, Chairman, Contact Member; R. W. Crum, Vice-Chairman, term ending January 1932; T. Chalkley Hatton, term ending January 1933; V. R. Covell, term ending January 1934; and Thaddeus Merriman, term ending January 1935.

COMMITTEE ON PHEBE HOBSON FOWLER PROFESSIONAL AWARD: Francis Lee Stuart, Chairman; J. N. Chester, J. M. Howe, Henry M. Waite, and F. E. Winsor.

COMMITTEE ON PHEBE HOBSON FOWLER ARCHITECTURAL AWARD: Director Morse, Contact Member, with the remainder of the committee to be appointed later.

COMMITTEE ON LOCAL SECTIONS: H. W. Dennis, Chairman, term ending January 1932; Murray Sullivan, Vice-Chairman, term ending January 1933; Robert Follansbee, term ending January 1934; N. T. Veatch, term ending January 1935; and Frederick C. Herrmann, Contact Member.

COMMITTEE ON JUNIORS: Robert J. Cummins, Chairman, term ending January 1932; E. N. Noyes, Vice-Chairman, term ending January 1933; A. M. Lund, term ending January 1934; H. P. Treadway, term ending January 1935; and A. T. Dusenbury, Contact Member.

COMMITTEE ON STUDENT CHAPTERS: W. W. Horner, Chairman, term ending January 1932; O. M. Leland, Vice-Chairman, term ending January 1933; J. J. Doland, term ending January 1934; appointee not yet named, term ending January 1935; and Clyde T. Morris, Contact Member.

COMMITTEE ON ENGINEERING EDUCATION: Langdon Pearse, Chairman, term ending January 1932; D. W. Meade, Vice-Chairman, term ending January 1933; A. H. Fuller, term ending January 1934; appointee not yet named, term ending January 1935; and A. F. Reichmann, Contact Member.

COMMITTEE ON PUBLIC EDUCATION: John F. Skinner, Chairman, term ending January 1932; C. J. Tilden, Vice-Chairman, term ending January 1933; W. D. Binger, term ending January 1934; Abel Wolman, term ending January 1935; and Charles H. Stevens, Contact Member.

COMMITTEE ON LEGISLATION: Miles E. Clark, Chairman, term ending January 1932; R. E. Koon, Vice-Chairman, term ending January 1933; Albert Givan, term ending January 1934; W. J. Roberts, term ending January 1935; Joseph Jacobs, Contact Member.

COMMITTEE ON REGISTRATION OF ENGINEERS: C. M. Reppert, Chairman, term ending January 1932; J. H. Herron, Vice-Chairman, term ending January 1933; L. L. Hidinger, term ending January 1934; R. E. Warden, term ending January 1935; and H. D. Mendenhall, Contact Member.

COMMITTEE ON SALARIES: E. P. Goodrich, Chairman; A. B. McDaniel, Vice-Chairman; E. O. Griffenhagen, Arthur E. Richards, William Reeves, and J. R. Slattery, Contact Member.

COMMITTEE ON REGIONAL MEETINGS:

Spring Meeting, Southern Region: J. N. Chester, Chairman; F. L. Nicholson, D. A. MacCrea, Allan T. Dusenbury, and H. D. Mendenhall.

Summer Meeting: J. M. Howe, Chairman; Joseph Jacobs, Frederick C. Herrmann, Franklin Thomas, and Roy C. Gowdy.

Fall Meeting: H. M. Waite, Chairman; Ralph Budd, Henry R. Buck, Clyde T. Morris, Edward P. Lupfer, A. F. Reichmann, and Charles H. Stevens.

COMMITTEE ON TECHNICAL PROCEDURE: Francis Lee Stuart, Chairman; Clyde T. Morris, Charles H. Stevens, Henry M. Waite, Roy C. Gowdy, the chairmen of the ten Technical Divisions of the Society, and George T. Seabury, Secretary.

COMMITTEE ON PROFESSIONAL ACTIVITIES: Francis Lee Stuart, Chairman; Allan T. Dusenbury, Frederick C. Herrmann, Joseph Jacobs, H. D. Mendenhall, Clyde T. Morris, A. F. Reichmann, Ole Singstad, J. R. Slattery, Charles H. Stevens, and George T. Seabury, Secretary.

COMMITTEE ON ACCREDITED SCHOOLS: H. P. Hammond, Chairman, term ending January 1932; A. E. Morgan, Vice-Chairman, term ending January 1933; Charles M. Spofford, term ending January 1934; Morris Knowles, term ending January 1935; Franklin Thomas, Contact Member.

Engineering-Economics and Finance Division Organized

Following a periodic expression of interest, extending over the past three or four years, the subject of the relation and importance of engineering economics and finance to the practice of civil engineering has attracted the active interest of a number of members of the Society. Through correspondence and personal contact, a group agreed to ascertain the extent to which the membership of the Society might become interested in the formation of a new Technical Division to devote itself to these matters.

Sufficient interest and evidence of cooperation was received to make up a signed petition containing over 60 signatures to be presented to the Board of Direction, meeting the requirements of the By-Laws of the Society, which provide for the consideration of the formation of a new Division upon the presentation of a petition signed by 20 members.

This petition was presented to, and considered by, the Board of Direction at its January meeting and the establishment of the new Division was accordingly authorized. The organization meeting was held in the Engineering Societies Building in New York on January 22, 1931. A proposed constitution, following closely the form outlined by the By-Laws of the Society for Technical Divisions, was read, adopted, and ordered presented to the Board of Direction for approval at its next meeting in April. The constitution thus gives the objects of the Division:

"The investigation, analysis, presentation, utilization, and making available of the principles, practices, and experience-results of such phases of business, economics, and finance as may be pertinent to the practice of the profession of engineering."

By unanimous action of the meeting, and to comply with the newly adopted constitution, a permanent Executive Committee, made up of the pre-organization committee of interested members was elected to carry on the work of the new Division. At the first meeting of this Executive Committee the term of each of the members was determined to be as follows: Ralph Budd, one year; Willard T. Chevalier, two years; Alonzo J. Hammond, three years; Charles Keller, four years; and Frederick H. McDonald, five years. Mr. Budd was elected chairman and Mr. McDonald, secretary.

The charter membership of the Engineering Economics and Finance Division is composed of those who signed the petition for the formation of the Division and of those present at the organization meeting, as follows:

C. Frank Allen
F. W. Altstaetter
J. W. Alvord
E. E. Barnard
William Joshua Barney
C. E. Beam
L. J. Bevan
Bernard Blum
Clarence E. Boesch
W. Bowie
J. H. Brillhart
Charles Carroll Brown
Ralph Budd
J. E. Cahill
J. N. Chester
Willard T. Chevalier
J. F. Coleman
Jacob L. Crane
W. W. DeBerard
Gano Dunn
Arthur J. Dyer
Harrison P. Eddy
Glen E. Edgerton
F. H. Fowler
Robert W. Gastmeyer
Ernest P. Goodrich
Charles Newton Green
J. E. Greiner
C. E. Grunsky
A. J. Hammond
Philip W. Henry
John Lyle Harrington
J. A. Higgs
A. E. Holcomb
L. G. Holleran
Joseph Jacobs
Nathan B. Jacobs
J. Houstoun Johnston
Charles Keller
V. H. Kriegshaber
W. S. Lee
C. F. Loweth
George L. Lucas
Ralph H. Mann
J. R. McColl
Charles A. McCollough
I. W. McConnell
Frederick H. McDonald
Hunter McDonald
Walter S. McDonald
Charles A. Mead
C. E. Myers
C. H. Paul
B. W. Pegues
William M. Piatt
Charles A. Pohl
George L. Reed
W. E. Reynolds
Walter A. Richards
Robert Ridgway
L. C. Sabin
Allen J. Saville
Thorndike Saville
Theodore E. Seelye
Harry L. Shaner
C. E. Smith
Walter M. Smith
C. M. Strahan
Francis Lee Stuart
W. G. Swendsen
Charles R. Thomas
Victor G. Thomassen
Charles E. Waddell
W. T. Walker
E. F. Wendt
Gardner S. Williams
J. E. Willoughby
Clyde M. Wood
John S. Worley
S. R. Young
G. A. Youngberg

There will be no conflict or overlapping of effort between the new Division and any of those already existing. However, it will deal with principles common to the work of all the other Divisions, and will very properly become, in its field, an agent for research which will be of use to them as well as to the membership of the Society in general, and the profession at large. The program of work to be carried out by the functional committees appointed by the Executive Committee of the new Division will be determined upon later, after consulting the members of the Division. The result of the canvass of the members of the Division will be formulated into a program to be presented at the October Meeting of the Society at St. Paul.

Tentatively, the scope of activity will include:

1. The analysis and correlation of pertinent information on the practice and requirements of banking, finance, law, real estate, alternate design, and the economic selection of location and materials as they affect engineering practice.
2. The discussion, organization, and presentation of such results for the benefit of the members of the Division, the Society, and the profession.
3. The correlation of such factors with pertinent organizations outside the profession, such as national, state, and municipal bodies, educational institutions, bankers, lawyers, realtors, builders, accountants, and manufacturers.
4. The study and presentation of proven principles affecting the business and legal relations of the engineer with his work, his clients, the builder, and the public.

To the many members of the Society who may wish to gain a better understanding of the aims and objects of the Engineering-Economics and Finance Division, this announcement is addressed. A considerable number of practicing engineers, whose work, either advisory or administrative, brings to their attention the larger economic and business phases of their technical problems, have begun to feel the lack of any organized forum for discussion. They feel the need of a source on which to draw for new ideas and for information on current practice regarding factors other than those connected with design.

Can the Engineering-Economics and Finance Division Help You?

If you are interested in the proposed aims and activities of the Engineering-Economics and Finance Division, you are invited to join it by indicating your desire on the coupon on page 584 of this issue. No money is required and enrolment may be accomplished by so simple a process as clipping the coupon, pinning it to your letter head, and forwarding it to the Secretary at Society Headquarters.

Turn to Page 584⟶

Attendance at Annual Meeting

In stating that the 1931 Annual Meeting brought out a record attendance, it is with a knowledge that records are only transient and not always dependable. This is particularly true of the exact number registered at this meeting. Apparently it numbered 2,000 or more; but in view of possible duplication and other inaccuracies, it seems safe to put the total registration at a figure of about 1,800.

Those who were present at any of the sessions will attest to the fact that a great interest was shown, and this extended throughout all the various sessions. As is often true, the entertainment and smoker on Thursday evening proved to be the gala attraction. Even before the time for the lecture, every seat in the auditorium

and gallery was taken. There were many, too, who were unable to gain admission and did not hear the address.

A similar popularity was evident even in the technical sessions. One of these, the afternoon meeting of the Structural Division, attracted a few more people than even the business session of the entire Society. This was the largest of the Technical Division meetings. As a matter of record the approximate attendance at all of the various functions was as follows:

Total registration	about 1,800
Annual Business Meeting	300
Construction Division	120
Highway Division	40
Structural Division:	
Morning	275
Afternoon	425
Power Division	120
City Planning Division	175
Wednesday luncheon	400
Dinner dance	515
Smoker	1,400
Friday excursion	250
Ladies entertainment	300
Inspection trips:	
Hudson River Bridge	230
Kill van Kull Bridge	80
Holland Tunnel	85
Empire State Building	480
Navy Yard	90

It was also notable that some of the Divisions which had the smallest attendance showed the greatest enthusiasm. For a considerable period on Thursday afternoon there were 750 or more people dividing their attention among three simultaneous sessions of Technical Divisions. This seems conclusive proof that members gathered from far and wide for more than mere sociability, and that the various officers and committees acquitted themselves well in setting up valuable technical programs.

Engineering Exhibits

A number of interesting engineering exhibits, some at the Engineering Societies Building and some at a distance, added to the enjoyment of visitors at the Annual Meeting. Occupying the corridor to the right of the auditorium, and used in conjunction with the symposium on the engineering work of Federal bureaus held Wednesday afternoon, there was an extensive exhibit of some of the work accomplished by the several Federal agencies. Samples of the engineering publications of the many departments covered a series of tables, including in some cases a generous supply of complimentary copies, while adorning the walls were many examples of maps and charts of Government origin.

The departments cooperating in this display included the Bureau of Standards, the Coast and Geodetic Survey, the Geological Survey, the Weather Bureau, the Corps of Engineers, and the Department of Agriculture, represented by the Bureau of Public Roads and the Division of Agricultural Engineering. These exhibits were visited and studied on both Wednesday and Thursday by a large number of the members in attendance.

On the ground floor an interesting series of colored transparencies were on view, furnished by the Highway Department of the State of New Jersey. Aerial views and close-ups of many features of the modern developments of highway work were on display. Concrete bridges and viaducts were notable, as were also striking examples of grade separation. Still other photographs showed the congested traffic situation at certain critical points. All in all, this exhibit was favorably received, not only for its engineering interest but for its distinctive artistic merits.

A special effort was made by the Museum of Peaceful Arts, in its own quarters, to display models of special interest to civil engineers. This was the object of a special trip on the part of members of the Structural Division, following its Thursday morning session. There on view was a model of the Kill van Kull Bridge, previously shown to Society members; representations of towers of several suspension bridges, as well as of other public engineering works; an electric extensometer which created a great deal of interest because of its great sensitiveness; and measuring apparatus to record the deflections and vibrations of buildings—to mention but a few of the outstanding attractions shown at the museum.

Finally, there was a notable exhibit set up at the Westinghouse Lighting Institute and visited by members of the City Planning Division in a body, following its Thursday afternoon session. Full-sized examples of apparatus for street lighting and building illumination were a revelation to all who saw them. The scale on which these displays were made and the great pains taken to depict faithfully the various situations proved a great attraction.

To all these various agencies who thus cooperated in adding their share to the general enjoyment of members the thanks of the Society are due. Members have often expressed regret that the facilities of the Engineering Societies Building have not been adequate to make such exhibits feasible in our own quarters. Fortunately, those special programs, which were instituted in connection with our meeting, were to be found within easy access, a fact which minimized the inconvenience. All of these efforts added to the value of the Annual Meeting.

High Lights of 1930

CLIPPED FROM THE ANNUAL REPORT OF THE BOARD OF DIRECTION

Three amendments to the Constitution prevailed in letter ballots during the year. By one amendment the number of meetings of the Board of Direction was set at a prescribed minimum of five instead of six. Another change increased the number of Directors from 18 to 19, the intent being to provide a more equitable representation in the territory made up of southern California and the Rocky Mountain states. By the third amendment the Constitution was changed so as to increase the prescribed minimum requirements for the several grades of membership.

* * * *

Adoption of the Functional Expansion Program accepted definitely for the Society an active and comprehensive participation in the non-technical matters incident to the profession. Committees to deal with matters of professional interest were authorized and three departments of Society work were established—technical, administrative, and non-technical. In effect, there was devised and set in operation a system whereby many members of the profession especially interested and especially qualified were called upon to contribute of their interest and effort.

The Committee on Registration of Engineers assumed vigorous leadership of the various engineering groups interested in the registration of professional engineers. The Committee on Charges and Method of Making Charges for Professional Services has produced a report and distributed it to the membership as *Manual No. 5*. For the use of clients, the committee has also produced an epitome of the report, published as *Manual No. 6*.

* * * *

The net growth of Society membership has been marked. Notwithstanding the degree of unemployment, which has been fully as observable among civil engineers as elsewhere, the net growth in 1930 exceeds that of the previous year by 13 per cent. It does not seem too much to say that, including those who contribute papers to the Society's publications and others who give individual efforts, not less than 3,250 of its members are engaged, with greater or less intensity, in the furtherance of its organized procedures. The records also show an attendance at the four quarterly meetings of the Society of 3,805, a larger figure than that of any preceding year.

* * * *

The Technical Divisions are the Society's specified agencies for the development of technical matters other than those specifically of a research nature. Their production, together with that of contributors to the publications, and the accomplishments of the research committees, constitutes the Society's part in the technical advance of the profession.

* * * *

The total number of applications for membership was 1,598 of which 1,260 were for admission, and 338 for transfer.

The permanent collection in the Engineering Societies Library now numbers 139,916.

Personal visits to the Library during 1930 totaled 25,113.

* * * *

The total number of publications issued by the Society during the year amounted to 27, containing in all 5,960 pages, and 1,024 illustrations.

* * * *

Attendance in the Reading Room during the year was 2,942.

* * * *

The number of members and others who took part in the preparation and discussion of the papers, discussion, and reports of committees published in PROCEEDINGS was 338.

* * * *

There are at present 51 Local Sections, the Tacoma Section approved by the Board on January 13, 1930, having been added during the year.

* * * *

There are now 13,067 members enrolled in the Technical Divisions, as follows:

City Planning Division	1,497
Construction Division	2,334
Highway Division	2,015
Irrigation Division	865
Power Division	759
Sanitary Engineering Division	1,558
Structural Division	2,533
Surveying and Mapping Division	732
Waterways Division	774

* * * *

In October 1929, a new service to the members of the Student Chapters was initiated, with the preparation and circulation of a series of lantern lectures on important engineering works. In October 1930, the number of different titles was increased to 13. During the year 1930, the total number of lectures delivered was 160.

Addition to Alfred Noble Prize

An interesting accretion to the Alfred Noble Prize Fund has recently been received. Its significance arises in part from the fact that it represents a participation in still another Society prize.

One of the awards for papers published by the Society and bestowed at the Annual Meeting was made to George Gibbs, M. Am. Soc. C.E. This was the Wellington Prize, consisting of $75 in cash and an engraved certificate. Through Mr. Gibbs' generosity, and by his specific request, this sum has been turned over by him to the Alfred Noble Prize. It will thus be added to the capital fund from which yearly awards are to be made to young members of the engineering profession. In this act, Mr. Gibbs makes a continuing investment in the award, which will have a peculiar significance to him, differing perhaps from the many other gifts which have gone to make up the Alfred Noble Prize Fund.

Exercises Conferring Honorary Membership

One of the distinctive yet unusually pleasant features of the Annual Meeting was the arrangement of the exercises bestowing Honorary Membership on John R. Freeman, Past-President of the Society. Ordinarily held during the Wednesday morning business session, this was transferred and elaborated for inclusion in the post-prandial exercises at the dinner dance on Wednesday evening, January 21.

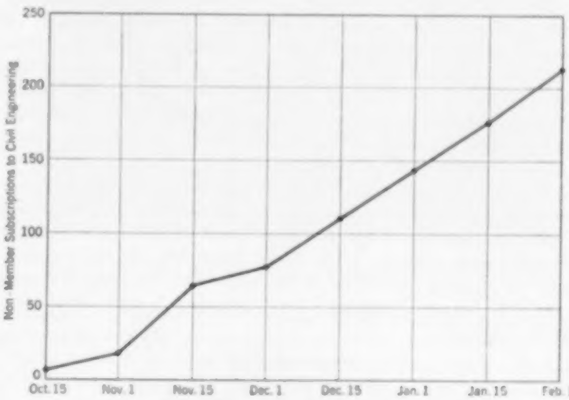
Immediately following the dinner, President Stuart introduced C. E. Grunsky, Past-President of the Society and now President of American Engineering Council, who had been selected to speak on the professional accomplishments of the new Honorary Member. An eloquent tribute was given by Mr. Grunsky to the activities of Mr. Freeman throughout a long and busy life of business and professional services, including his many contributions to the advancement of engineering thought and practice.

The next speaker, Charles T. Main, M. Am. Soc. C.E. and former president of the American Society of Mechanical Engineers, spoke of Mr. Freeman as a man. This was in fact a most intimate appraisal of an interesting personality, dating back to college days and extending through all the course of a close personal and professional acquaintance.

With his usual felicity, Mr. Freeman, after accepting the certificate from President Stuart, responded to both amusing and serious comments. Immediately following, the new President of the Society, together with Mr. and Mrs. Freeman, held an informal reception in the adjoining foyer.

Subscriptions Are Mounting

Since its inception, CIVIL ENGINEERING has attracted an increasing number of subscriptions from outside sources, as indicated in the appended diagram. So far, the curve of growth has been remarkably regular. While it is hardly to be expected that this favorable record will continue indefinitely, it is a matter of satisfaction that the publication is making an increasing appeal.



GROWTH OF SUBSCRIPTIONS

It is to be noticed that the subscriptions mentioned are all from non-members of the Society. Some subscribers are individuals and some are organizations, including not a few libraries; about one in every eight is foreign. It is significant, too, that each sees a cash value in the publication, the cost of which, to members, is included in the annual dues.

Elections by Technical Divisions

According to the constitutions of the various Technical Divisions, administration is vested in an executive committee of five members. To these committees one member is elected each year from a series of three names proposed by a nominating committee. The officers thus elected for five years each have overlapping terms, ensuring continuance of policies within the Division.

Under the plan, each of the Divisions elected one additional member of its executive committee at the polls canvassed last January, with the following results:

City Planning Division, Charles F. Loweth, Past-President, Am. Soc. C.E.
Construction Division, Dean G. Edwards, M. Am. Soc. C.E.
Highway Division, E. W. James, M. Am. Soc. C.E.
Irrigation Division, R. K. Tiffany, M. Am. Soc. C.E.
Power Division, J. C. Stevens, M. Am. Soc. C.E.
Sanitary Engineering Division, Charles Gilman Hyde, M. Am. Soc. C.E.
Structural Division, T. L. Condron, M. Am. Soc. C.E.
Surveying and Mapping Division, R. H. Randall, M. Am. Soc. C.E.
Waterways Division, Charles W. Kutz, M. Am. Soc. C.E.

New officers of the Engineering-Economics and Finance Division, just authorized by the Board of Direction, are noted elsewhere in these pages.

Laying Plans for the Norfolk Meeting

Many reasons should induce members to attend the Spring Meeting of the Society at Norfolk, Va., on April 15, 16, and 17, 1931, whether they are interested in increasing their store of knowledge or are willing to impart to others some of the benefits of their experience in things of mutual interest. There will be many old friends glad to have this opportunity, under such pleasant conditions, to clasp hands again, and others to renew friendships almost forgotten.

For those in search of encouragement, inspiration, recreation, or the beauties of nature—or just a trip into a land of sunshine, history, and good things to eat—Norfolk and Virginia Beach are recommended, especially in the spring time. The Virginia Committee, with the aid of representatives from the entire Southern region, will see to it that visitors get every joy out of their trip. As they declare, "You may desire anything and not be disappointed."

For one thing, members will want to see the progress being made in the restoration of Williamsburg to its old Colonial splendor. There the program will be explained by Dr. W. A. R. Goodwin, Rector of old Bruton Parish Church, who was instrumental in starting this gigantic piece of work and has it in charge. This restoration includes the second oldest college building in America, the ancient Colonial Capitol building, and the Governor's Palace, to say nothing of the Raleigh Tavern where Phi Beta Kappa was founded and where the Colonial patriots and the disbanded General Assembly met and planned revolutionary activities under the very nose of the Royal Governor.

This spring session gives everyone an opportunity for a real vacation, combining an instructive Society Meeting with a pilgrimage to national shrines. For a golfer, it will be a real paradise—golf courses with a beauty never to be forgotten, the air heavy with the odor of pine and the tang of the sea. The Virginia Committee will not be satisfied unless every member adopts the slogan, "Norfolk in April."

Transactions Popular in Foreign Countries

A cursory examination of the mailing list of subscribers for Society PROCEEDINGS and TRANSACTIONS reveals some most interesting relations. For instance, the total subscriptions amount to 459—a quite appreciable number in itself. Of most interest, however, are the individual subdivisions of this entire list among the various countries. First, of course, would come the United States. Subscriptions here are complicated by the fact that about 14,700 persons already receive the publications by virtue of Society membership. Even so, its total of 90 subscribers provides a basis on which to judge the others. But this is not the maximum, nor is the country which holds the palm easy to guess. It is Japan, where the subscriptions amount to the astounding total of 119, or over one-quarter of the entire number.

Perhaps more astonishing is the next country on the list, the Union of Socialistic Soviet Republics, which has a record of 66 subscribers. Although this is little better than half as many as Japan, its significance becomes more striking when it is discovered that the next nearest nation has only 25 subscribers.

These figures are impressive as showing not only how widely the interest in Society publications extends but, more especially, how deep it is. PROCEEDINGS and TRANSACTIONS are considered at their true worth both at home and abroad.

Badges for Society Affiliates

With the new constitutional requirements, recently adopted, the status of Affiliates in the Society has been materially raised. Requirements for such membership are now on a high plane, comparable in quality of work, if not in the actual field of experience, with Corporate Members of the Society. In view of this, the Board of Direction ruled that henceforth Affiliates shall be privileged to wear the same badge as Corporate Members.

In effect, this will eliminate the maroon-colored badge, otherwise similar to that of Corporate Members and now worn only by Affiliates. Maroon, however, will still be worn on the students' pin.

Noted Engineers Pass Away

Within the space of a few days the Society has suffered the loss of two of its well known members—George S. Webster, Past-President of the Society, who died on January 23 in Philadelphia; and Luigi Luiggi, Honorary Member, who died on February 1, in Rome, Italy.

Since 1892, Mr. Webster has been affiliated with the Society and prominent in its work. His service, both as Director and Vice-President, was rewarded by election to the Presidency in 1921, following which he spent the succeeding five years as Past-President on the Board of Direction. Until recent years, therefore, he continued active in Society affairs.

Because of his frequent visits to this country and his sympathy and admiration for American engineering accomplishments, Senator Luiggi was very popular with American engineers. In his own country he was indeed a noted man, having been rewarded with one of the highest honors in the power of the Italian nation to bestow, when he was made senator. He was first connected with the Society in 1906, and in 1921 was made an Honorary Member, a fact of which he was very proud. It is intended that more extended biographical notes of these two well known engineers shall appear in due course in TRANSACTIONS.

To Increase Value of Meteorological Records

For some time a feeling has been prevalent among engineers who habitually use meteorological records furnished by the Government, that improvement could be made in the collection and dissemination of such information. This belief has been freely discussed among various Western Local Sections and elsewhere.

Crystallization of thought was brought about by action of the Executive Committee of the Irrigation Division at its meeting last August, when it requested the Society "to appoint a committee that is well distributed geographically to make a study of methods and records of the U.S. Weather Bureau, particularly relating to additional stations, annual inspection of stations, and a uniform system of records throughout the country."

Acting on this request, the Board of Direction at its January meeting endorsed this recommendation and authorized the appointment of such a committee by the President.

Appointments of Society Representatives

KENNETH H. OSBORN, M. Am. Soc. C.E., has been appointed an additional representative on the Sectional Committee on Development of Safety Code for Grandstands, under the auspices of the American Standards Association.

THOMAS BUCKLEY, PHILIP H. CARLIN, and CHARLES A. HOWLAND, Associate Members Am. Soc. C.E., have been appointed Society delegates to the Thirty-fifth Annual Meeting of the American Academy of Political and Social Science to be held in Philadelphia, April 17 and 18, 1931.

ARTHUR E. MORGAN, M. Am. Soc. C.E., and HAROLD A. THOMAS, M. Am. Soc. C.E., were appointed representatives at the Annual Meeting of the American Association for the Advancement of Science, held December 29, 1930, at Cleveland, Ohio.

J. J. YATES, M. Am. Soc. C.E., was appointed as one of the Society's representatives on the Engineering Societies Library Board for the three-year term, January 1931 to January 1934.

OLE SINGSTAD and CHARLES H. STEVENS, Directors Am. Soc. C.E., have been appointed as the Society's representatives on the Engineering Societies Monograph Committee, each of the four Founder Societies having two representatives.

W. P. ROTHROCK, M. Am. Soc. C.E., represented the Society at the Seventy-Fifth Anniversary of the Founding of the Pennsylvania State College, State College, Pa., October 17, 1930.

ROBERT S. WESTON, M. Am. Soc. C.E., represents the Society on American Engineering Councils' Joint Committee on Oil Pollution, of which he has been elected chairman. ABEL WOLMAN, M. Am. Soc. C.E., also representing the Society, is now secretary of the same committee.

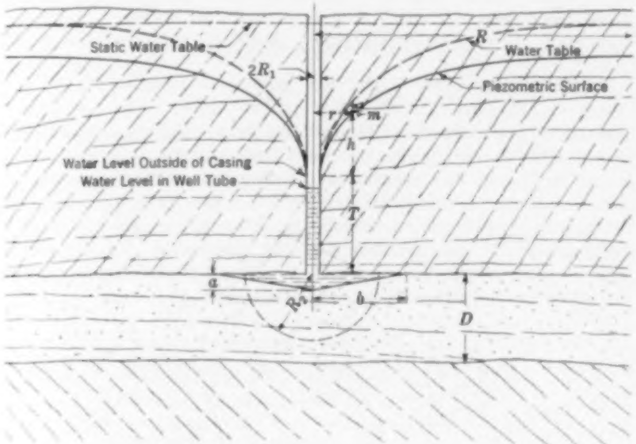
A Preview of Proceedings

A noticeable feature of the March issue of Proceedings will be the large volumes of interesting and important discussions of current papers. More than a dozen papers are being discussed, not only by members in the United States, but by attentive readers of Proceedings in the far corners of the earth.

The Flow of Ground Water as Applied to Drainage Wells

Three types of deep wells for the drainage of irrigated lands are described in this paper by M. R. Lewis, M. Am. Soc. C.E.—(1) artesian wells (not necessarily flowing) with a perforated casing that extends through the water-bearing stratum; (2) wells in which the water table is in the water-bearing stratum and which penetrate the full depth of the stratum; and (3) open-bottom wells that reach just to the water-bearing stratum.

Each of these cases is treated separately under assumptions of horizontal flow and vertical flow by percolation. In his paper Mr. Lewis reaches the conclusion that, if the area to be drained is more than a few hundred feet in diameter, successful drainage will depend on a general lowering of the water table.



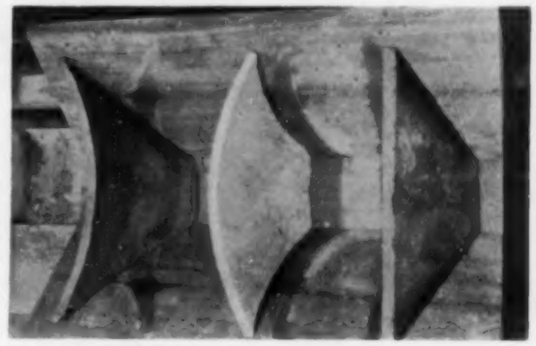
Open-Bottom Well Extending to Water-Bearing Stratum

To secure such lowering, he states, wells should be designed for the greatest possible capacity consistent with an economical lift. The shape and extent of the draw-down curve, or cone of depression, is particularly important, since the cost of power is a controlling factor in irrigation pumping.

The shape of the draw-down curve will depend on the size and character of the well and on its relation to the water-bearing strata and the source of the water supply. Theoretical formulas and curves for the three cases defined are given in the paper.

Gravity Dams Arched Downstream

For some time, especially since the failure of the St. Francis Dam in March 1928, B. J. Lambert, M. Am. Soc. C.E., Head of the Department of Civil Engineering of the State University of Iowa, has been interested in the merits of curving gravity dams when the location is in a canyon. This paper, to appear in the March issue of Proceedings, describes observations made on a small scale model at the State University of Iowa. The models were constructed in a wooden trough to a scale of 1:240, that is, 1 in.–20 ft.



Three Types of Model Dams on Canyon Sites

Basically, Professor Lambert questions whether a gravity dam might not preferably be straight rather than curved upstream. If it is to be curved, he believes that there is an advantage in curving the dam downstream. The paper presents data to support this theory. The basis of this study is an assumption that the dam will act as a unit. While construction and shrinkage cracks cannot be eliminated, he points out that the sections will more or less interlock. Regardless of whether or not engineers agree with him, it must be admitted that the subject offers food for thought.

While the paper offers St. Francis Dam as an example of a site to which this problem might be applied, it must not be considered a reopening of the discussion on the failure of the St. Francis Dam, which has been closed to discussion in a previous paper. The author is interested in the relative merits of curving gravity dams at canyon sites.

How many will attempt to answer this question, "Should gravity dams in a canyon be arched and if so, how?"

Salary Studies Progress

Early in December, a questionnaire regarding salaries was sent to each member of the Society. During the next few weeks a great many took the time and effort necessary to fill out this blank and return it to the Committee on Salaries. By January 28, the total number of replies amounted to 5,325. Most of these were from members of the Society. About 8,000 questionnaires were sent to non-members, bringing the total number issued to about 22,500. Therefore, if the returns were in proportion to the number sent, approximately two-thirds of those now available give the salary experiences of Society members.

From this number it is judged that possibly a total of 5,500 replies will be available. This is considered a very creditable showing in terms of proportionate response. Many questionnaires of this sort are satisfied with a small percentage of replies, while 25 per cent is considered remarkably good. It certainly is a most creditable showing, indicating the intense interest of engineers in this matter. One element of especial value in such a number is that, by distributing the experience over a relatively large group, the accuracy of the average finding is correspondingly increased. The data to be yielded by this research will be awaited by the profession with increasing interest.

New Society Units

Additions to the organizations within the Society, both with respect to Local Sections and Student Chapters, were ratified by the Board of Direction at its January meeting.

The institution of a Local Section at Panama will recall many memories to the host of members who, during active Canal construction, were familiar with the "Isthmus." Both the Canal Zone and the Republic of Panama are included in the territory from which members of this Section will be drawn. The first meeting of the Panama Section is reported elsewhere in this issue.

The other Local Section authorized was in the South. For some time the interest of members in and around Montgomery, Ala., has been growing. The movement for institution of a Local Section came to a head during a visit by J. F. Coleman last October, when he was President of the Society. The new group will be known as the Alabama Section.

To the already large list of Student Chapters have been added the names of Harvard University and the Michigan College of Mining and Technology. As a result of all these actions, the total number of Local Sections will become 53, and of Student Chapters 97, as soon as the necessary qualifying formalities are complied with.

News of Local Sections

Cincinnati Section

A dinner meeting of the Section was held jointly with the Student Chapter of the University of Cincinnati on January 9, with 35 members in attendance. The feature of the evening was an address by John D. Ellis, Director of Law for the City of Cincinnati, who spoke on the engineer's status in government.

Cleveland Section

At a dinner meeting of the Cleveland Section held on January 6, in honor of former presidents of the Section, Dr. William E. Wickenden was the principal speaker. The subject of his talk was the education of the engineer. There were in attendance 44 members, including a number from the Student Chapter of the Case School.

Business routine occupied the attention of the 33 members present at the luncheon meeting of February 3.

Colorado Section

The regular meeting of the Section was held in Denver, January 19, with 95 members and guests in attendance. The program of the evening consisted of a "Progress Report on the Hoover Dam," given by the engineers of the U.S. Bureau of Reclamation. Included among the speakers taking part in this presentation were E. H. Debler, Hydraulic Engineer; B. W. Steele, Engineer of Dams; and L. N. McClellan, Electrical Engineer, who spoke on aspects of the study ranging from provisions of the Colorado River Act to the materials available for use.

Dayton Section

An interesting program was enjoyed by the 20 members present at a meeting of the Section held at the Engineers' Club, January 12. The guest and speaker of the occasion was Prof. C. E. Sherman, of Ohio State University.

District of Columbia Section

Election of 1931 officers for the District of Columbia Section has resulted as follows: William H. Richards, Jr., President; John S. Conway, Vice-President; and Frederick W. Amadon, Secretary-Treasurer.

An informal dinner meeting of the Section was held in Washington, January 28, the speakers of the evening being Maj.-Gen. Amos A. Fries, Consulting Engineer; and C. K. Moser, of the U.S. Department of Commerce. The former spoke on "Reminiscences of Thirty-three Years in Engineering," and the latter on "American Influence in the Far East."

Duluth Section

On January 19, the Duluth Section held a luncheon meeting, at which Col. E. E. Corry, of the office of the U.S. Engineers at Duluth, spoke. Colonel Corry dealt with the subject of the problems presented in the determination of awards for damages, sustained by settlers in the Lake of the Woods region, as a result of the construction of dams that have raised the water level. This controversy has been before the International Joint Commission for several years. Attendance at the meeting numbered 16 members and 2 guests.

Florida Section

At a meeting of the Section held on December 30, 1930, officers for the current year were elected as follows: George B. Hills, President; and Robert M. Angas, Secretary-Treasurer. A Board of Directors, consisting of these two officers and Gilbert A. Youngberg, was also elected.

Georgia Section

Attendance at the January meeting of the Section, held in Atlanta, January 5, numbered 22. Included in the business session was the reading of various committee reports. Then H. F. Wiedeman, President of the Southeastern Water Works Association, presented an illustrated lecture on water purification in the Southeast, with special application to the water supply problems of Georgia. Stream pollution in the state was the subject emphasized by W. H. Weir, of the Georgia State Board of Health, in the other address of the occasion.

Members attending the February meeting of the Section, held in Atlanta, February 2, heard the report of F. H. McDonald, Executive Secretary of the new Division of the Society, known as the Division of Engineering-Economics and Finance. The speaker of the occasion was F. W. Hacker, his subject being "The Sewer Survey of Atlanta."

Illinois Section

Meetings of the Illinois Section were held January 5 and 15. The speaker at the first of these meetings was Colonel Ohlson, General Manager of the Alaskan Railroad, whose subject was "Alaskan Transportation." At the second meeting, Samuel O. Dunn, Editor of the *Railway Age*, spoke on "The Transportation Situation." At the close of 1930, it was found that the membership of the Section totaled 404, a considerable increase over previous years.

Kansas State Section

At a meeting held in Topeka, January 23, the nominating committee reported as follows: E. H. Connor, President; and W. C. McNown, Vice-President. This report of the nominating committee was approved, and as no other nominations were made, the Secretary was instructed to cast the ballot of the Section for these candidates' names.

Los Angeles Section

At the first meeting of the new year, held January 14, the new president, Robert Linton, was in the chair. The attendance numbered approximately 70, and the Junior Forum as usual preceded the regular meeting. After the routine business session, which included the reading of various committee reports, the subject of the evening, "Conservation," was presented by three speakers. These were C. M. Gregg, Manager of the Los Angeles By-Products Company; Martin Van Couvering, Petroleum Engineer; and O. W. Heinz, of O. W. Heinz and Company, all of whom presented different aspects of the subject.

Maryland Section

A joint meeting of the Section was held in Baltimore, January 16, with the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Engineers' Club of Baltimore. There was the large attendance of 1,400 at this meeting, as the feature of the occasion was a lecture by Sergius P. Grace, Assistant Vice-President of the Bell Telephone Laboratories, on "The Marvels of Sound Transmission." The stage was equipped with a large number of devices for illustrating this talk, and Mr. Grace gave interesting demonstrations of the marvels of the telephone industry.

Milwaukee Section

Business procedure occupied a part of the session of the meeting held at the City Club, January 7, at which 34 members, and 5 guests were present. Committees were appointed to direct the various divisions of the Section's activities during the coming year. The honor guest of the occasion was Harrison P. Eddy, Consulting Engineer of Boston, and a Director of the Society, who gave an interesting talk on certain aspects of Society affairs.

New Mexico Section

Officers for 1931 were elected at the annual meeting, held at Albuquerque, December 16, as follows: Paul S. Fox, President; R. G. Hosea, First Vice-President; W. C. Davidson, Second Vice-President; and Wilbur B. Ream, Secretary-Treasurer. The attendance numbered 40 members and guests, who enjoyed a dinner and entertainment program. It was voted that J. L. Burkholder, the retiring president, as well as all future retiring presidents, should be presented with an emblem in recognition of faithful service.

Oklahoma Section

Results of the election of 1931 officers for the Oklahoma Section are as follows: L. M. Bush, President; W. E. Davis and A. H. Riney, Vice-Presidents; and J. F. Brookes, Secretary-Treasurer.

Panama Section

The Panama Section, authorized by the outgoing Board of Direction at its meeting on January 19 1931, has elected the following officers: President, E. Jaen Guardia; and Secretary-Treasurer, L. B. Moore, Box 246, Balboa Heights, Canal Zone.

Philadelphia Section

"Mississippi River Flood Control" was the subject of discussion at a meeting of the Section held at the Engineers' Club, January 29. Attendance at the dinner numbered 48, and at the meeting 75. The speakers were Lt. J. P. Dean, Engineers Corps, U.S.A.; and Charles S. Hill, Associate Editor, *Engineering News Record*, both of whom described various important levee projects.

Portland Section

The annual meeting of the Section was held at the University Club, January 9, with 50 members and guests in attendance. Business routine of the meeting included election of the following officers for the current year: O. E. Stanley, President; J. W. Cunningham and H. A. Rands, Vice-Presidents; C. F. Thomas, Secretary; and G. H. Canfield, Treasurer.

Rochester Section

At the annual meeting of the Rochester Section held January 8, officers for the current year were elected: C. Arthur Poole, President; Robert B. Jeffers, First Vice-President; Henry L. Howe, Second Vice-President; and Carl C. Cooman, Secretary-Treasurer.

Sacramento Section

Meetings are held by the Sacramento Section on an average of once a week. During the December series of meetings the membership heard addresses by O. G. Stanley, of the U.S. Engineering Department; C. F. Adams, Assistant Superintendant of the Oleum Plant of the Union Oil Company; and Donald R. Warren, Construction Engineer on the San Mateo-Hayward Highway Bridge, the longest in the United States.

At the meeting on January 6, C. E. Grunksy, Past-President of the Society, addressed the members on "Some Early History of the State Engineers' Office." On January 9, officers for the current year were elected as follows: S. H. Searancke, President; H. M. Stafford, First Vice-President; Carl Maughmer, Second Vice-President; and Norwood Silsbee, Secretary-Treasurer. The Section's membership is at present 128, which represents a gain of 16 during the past year.

Seattle Section

The feature of the regular monthly meeting of the Section, held at the Engineers' Club, December 2, 1930, was an address on "Geophysical Prospecting" by Asa Baldwin, who described the Schlumberger methods of electrical prospecting as applied on various rivers. There were 28 in attendance.

At a meeting of the Section, held at the Engineers' Club December 30, R. M. Murray, Resident Engineer for the Aurora Bridge project, gave an interesting account of the construction of the main piers for this bridge. The attendance numbered 32.

An illustrated lecture on the suspension cable construction of the Philadelphia-Camden Bridge across the Delaware River by Hugh Hurlow, Jr., District Manager for the American Cable Company was the feature of a meeting of the Section, held January 27. The election of officers for 1931 resulted as follows: William F. Way, President; E. L. Strandberg Vice-President; and Thomas D. Hunt, Secretary-Treasurer. There were 45 in attendance.

St. Louis Section

A luncheon meeting of the Section, held January 26, was the occasion for an address by C. D. Purdon, who spoke on the building of the Suisun Bridge at San Francisco and told of some of the details of construction which do not usually find their way into print. Reports were also given by Baxter L. Brown and W. W. Horner on the Annual Meeting of the Society recently held in New York.

Tacoma Section

At the January 12 meeting of the Tacoma Section, W. C. Raleigh spoke on the proposed Stampede Pass Cut-off connecting the Sunset and Natches Pass highways. This project, involving difficult engineering problems, would provide an all-year commercial highway linking eastern and western Washington. The meeting had an attendance of 28.

Student Chapter News

College of the City of New York Student Chapter

A report from the College of the City of New York Student Chapter indicates that the past year has been an active one for members of the Chapter. Meetings were held at frequent intervals, and several interesting speakers were heard. Among these were William B. Meyer, of the Fairchild Aerial Survey Company; J. E. Griffin, of the National Paving Brick Manufacturers Association; and David B. Steinman, of Steinman and Robinson, Bridge Engineers. Election of officers for the current year took place at the January 8 meeting, and resulted as follows: A. Kahan, President; H. Rubinstein, Vice-President; Herbert E. Smith, Secretary; and Malcolm H. Hammerschlag, Treasurer.

Polytechnic Institute of Brooklyn Student Chapter

During the past year various interesting programs have been given by the Polytechnic Institute of Brooklyn Student Chapter. Among those who addressed the meetings were Wayne C. Heydecker, Associate Director of the Regional Plan Association; Leicester Durham, Assistant Engineer of the New York City Board of Estimate and Apportionment; and Paul N. Kruse, Water Power Engineer of Sanderson and Porter. Inspection trips were also made to various points of engineering interest in and about New York City. Officers for the coming year are as follows: William Ackerson, President; Wilbur G. Law, Vice-President; Albert F. Snyder, Secretary; and Gerner Olsen, Treasurer.

University of California Student Chapter

Four regular meetings and two trips comprised the past semester's activities in this chapter. The first of the inspection trips was made to the fender pier of the Carquinez Bridge, and the second to Mare Island Navy Yard. Incoming officers for the spring semester, 1931, are as follows: Richard C. Lombardi, President; George W. Burgess, Vice-President; Sterling S. Green, Secretary; and Scott H. Lathrop, Treasurer.

Many Members Engaged in Society Work

One significant test of the virility of an organization is the number of members whom it can interest actively in the promotion of its work. Judged on this basis, the Society is indeed fortunate in being able to point to almost one-third of its membership with definite Society obligations which were being fulfilled during the year 1930. Such an unbelievable total requires actual figures for its substantiation. Here they are.

Committees doing active work for the Society number 208, with a total personnel of 1,569. Then there are committees, concerned exclusively with Local Section duties, to the number of 377, embracing 1,702 members. In addition will be found more than 500 members who have written papers or discussions or have served as joint representatives of the Society during the year 1930. The gross total of 3,975, or almost 30 per cent of the membership, (33 per cent of the Corporate Membership) gives a fair idea of the extent of participation in definite active Society matters.

In this total number, however, will be found some duplication, particularly where a member may serve in more than one capacity. Applying therefore the deduction of somewhat more than 700 for these duplications, the net figure gives the total of 3,250 individual members engaged. This gratifying total must be viewed in the light of the type of membership considered, of whom large numbers in inaccessible localities, and many others who would be valuable additions to Society work, are not so situated as to be able to enjoy Local Section affiliation.

From any viewpoint, therefore, the surprising total evidences an unusual willingness to participate in Society work. To this fine state of cooperation and widespread interest is attributed much of the success of the Society as an organization.

ITEMS OF INTEREST

Engineering Events in Brief

Dr. J. A. L. Waddell to Receive the Clausen Medal

As ANNOUNCED last fall, the first award of the Clausen Gold Medal has been made by the American Association of Engineers to John Alexander Low Waddell, M. Am. Soc. C.E., Consulting Bridge Engineer of New York. With the cooperation of the other national engineering societies, a dinner will be given at the Hotel Astor, New York, on the evening of March 11, at which the award will be presented to Dr. Waddell for the most distinguished service performed by any citizen of the United States for the welfare of engineers, social, economic, or both.

Although the award will, in the future, be made annually, the first medal is peculiary distinguished as it is given not only for service for a single year, as will hereafter be the measure of merit for its recipient, but in this case, for the whole period of more than 50 years that Dr. Waddell has devoted to the unselfish advancement of his profession. During a life of active and successful engineering practice, which has taken him to many foreign countries, he has given freely of his time, his energy, and his accumulated store of knowledge to the young and old of the profession. His studies of alloy steels in bridge construction, his laboratory tests and records, computations and analyses, and his professional experiences have been prepared, often with large expenditures of his own time and money, for their use and advancement. He has been honored abroad with numerous foreign decorations, and at home with the highest professional appreciations.

The award has been made by a committee of 11 eminent engineers and scientists who publicly invited the cooperation of engineers and others to nominate eligible candidates. After a long and thorough deliberation, the committee unanimously chose Dr. Waddell as the recipient of the first Clausen Gold Medal. Preparations have been made for a large attendance, including ladies, at the presentation dinner, and addresses by eminent engineers and other distinguished citizens will emphasize the economic, ethical, and professional relations of the engineer to society. Requests for reservations should be addressed to A. M. Knowles, 71 West 23d Street, New York, N.Y.

Movies of Chute à Caron Dam Available

WHEN the Chute à Caron obelisk was blasted into place, the Aluminum Company of America was fortunate in obtaining an unusually satisfactory motion picture of this brilliant piece of engineering. This film has been shown as a news reel and, on the occasion of the Society smoker at the Annual Meeting in New York, it gave much pleasure to the engineers and their guests.

A part of the pictures are in normal motion, and a part in slow motion, the latter showing clearly the movement of the huge mass of concrete after the supporting pier was blown away. The film is 1,000 ft. long, printed on 35 mm. of safety film, and requires under 15 minutes to run. Animated maps and complete titling make the film entirely self-explanatory.

So much interest has been shown in this unique piece of work that the Aluminum Company of America has offered to make the film available on request—addressed to its Pittsburgh Office—to engineers, engineering societies, and colleges. In the December 1930 issue of CIVIL ENGINEERING, C. P. Dunn, M. Am. Soc. C. E., described in detail the planning and execution of this bold undertaking.

COMING EVENTS

NORFOLK IS NEXT!
Spring Meeting of the American Society of Civil Engineers Convenes in Norfolk, Va.
April 15, 16, 17, 1931

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
District Meeting will be held in Pittsburgh, March 11–13.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS
Will meet in Birmingham, April 20–23.

AMERICAN SOCIETY FOR TESTING MATERIALS
Regional Meeting will convene at the Hotel William Penn, Pittsburgh, March 16–20.
New York District Meeting will assemble at the Hotel New Yorker, New York, March 5.

ANNUAL WELDING SYMPOSIUM
Will be held at Lehigh University, Bethlehem, Pa., March 27.

NATIONAL RAILWAY ENGINEERING ASSOCIATION
Annual Convention will be held in Chicago, March 9–12.

NORTHEAST ELECTRIC LIGHT AND POWER ASSOCIATION
Engineering Section will meet in Wenatchee, Wash., March 18–20.

ROAD REGIMENT'S REUNION
First National Reunion of the 23d Engineers who served during the World War, Hotel Astor, New York, March 19, 20.

Washington Award to Ralph Modjeski

IT HAS been announced that the Washington Award, administered by the Western Society of Engineers, has been given to Ralph Modjeski, M. Am. Soc. C.E., Consulting Bridge Engineer of New York. The award was founded in 1915 by John W. Alvord, M. Am. Soc. C.E., and it takes the form of a bronze medal or some other work of art, "as an honor conferred upon a brother engineer by his fellow engineers on account of accomplishments which preeminently promote the happiness, comfort, and well-being of humanity."

The Commission of Award consists of nine members of the Western Society of Engineers and two members each from the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers. The presentation of the award took place in Chicago on February 25.

International Exposition for Housing and Town Planning

DURING the period from May 9 to August 9, an International Exposition for Housing and Town Planning is to be held in Berlin under the auspices of the German Building Exposition, 1931. As each nation will send exhibits showing the characteristic features of its housing and town planning methods, the exposition is arousing considerable interest throughout the world, especially among architects, builders, and town planners. It will make possible an interesting and constructive comparison between the work being done in various countries.

All architects, engineers, city planners, and others who are interested, are cordially invited to attend this exhibition. Inquiries may be addressed to the Secretary of the Society, at Headquarters.

Huge Steel Casting Poured

HISTORY was made in the Lehigh plant of the Bethlehem Steel Company, when, on January 23, the largest steel casting ever made having a weight of 460,000 lb., was knocked out of the mould. The casting is a platen, or cylinder jacket, for the 14,000-ton forging press of the Bethlehem plant. Up to the present time such devices have been built up of separate parts because of the technical difficulties involved in casting a single piece of this size. The casting occupies a cubic space comparable in size to an old-fashioned drawing

room, having a height of 12 ft. 10 in., a length of 23 ft. 4 in., and a width of 10 ft. 2 in.

Six open hearth furnaces were used to melt the steel for the required metal. One of the problems in the job was the difficulty in getting these six furnaces in step so as to be tapped at the proper time. Metal for the casting was poured simultaneously through four different runners, or troughs, one at each end of the mould and two at the side. Five ladles of metal were on hand during the pouring, including the standby ladle.

The pouring of the casting, exclusive of the sink heads, was accomplished in approximately 10 min., and the total pouring time, including the heads, required 38 min. Although the pouring of the molten metal is the crucial and most spectacular part of the operation, it was a small fraction of the total job, which consumed about ten weeks. The cores for the cylinder holes were, in effect, solid brick shafts, and were made in three sections to permit ease in handling. Similarly, the column cores were made in halves. Pattern and core boxes required a total of 13,000 ft. of lumber and 2,000 man hours of labor.

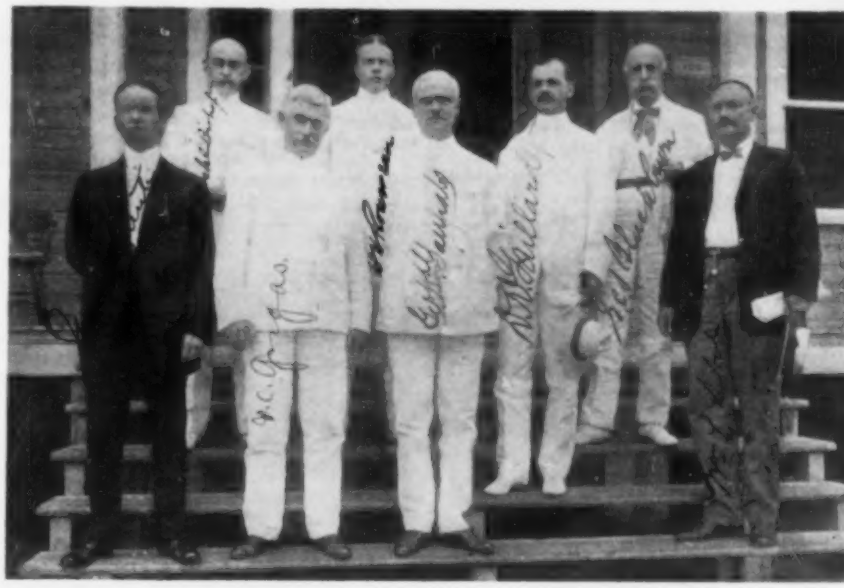
The mould was made in a large concrete pit, with heavy steel reinforcing over the full surface of the mould. To guard against possible rupture of the concrete pit, due to the weight and hydrostatic pressure of the molten metal, adjacent pits were filled in and reinforced. The pattern was ready for drawing from the mould on December 13, 1930, and due to its construction and size this process required an hour.

To provide rapid cooling of the molten metal as it came in contact with the surface of the mould, two tons of nails were used over the surface of the mould. Prior to the pouring, it was essential to have the mould thoroughly dry to a depth of 12 in. This required not only hot air, but adequate circulation. An unusual method was used by leading into the mould a pipe fitted with a blower, which circulated dry heated air from a core oven.

After drying the mould and the cores, the latter were set in the mould properly secured, and the cope was placed on top, with approximately one million pounds of weights to prevent the cores from floating in the molten metal during the pouring. The casting was left in the mould ten days before any cleaning was attempted. After that time the cope was removed and the greater portion of the sinkheads were burned off with acetylene. Two 120-ton cranes lifted the casting from the pit and loaded it into a car for transfer to the annealing furnace.

Illinois Society of Engineers Elects Officers

At its annual meeting in Rockford, Ill., on January 28, 1931, the Illinois Society of Engineers elected the following officers: President, Harry F. Ferguson, Assoc. M. Am. Soc. C. E., Chief Sanitary Engineer, Illinois State Department of Health; Vice-President, Hugh J. Fixmer, of Chicago; Secretary, Harold E. Babbitt, M. Am. Soc. C. E., Professor of Sanitary Engineering, University of Illinois.



ISTHMIAN CANAL COMMISSION, ANCON, 1906

This photograph, the original of which recently came into the possession of the Society through the courtesy of Arthur Richards, M. Am. Soc. C.E., is especially of interest because of the autograph signatures. From left to right, Jackson Smith, Joseph Bucklin Bishop, Col. W. C. Gorgas, H. H. Rousseau, Lt.-Col. Geo. W. Goethals, Maj. D. D. Gaillard, Jo C. S. Blackburn, and Maj. Wm. L. Sibert.

NEWS OF ENGINEERS

LAWRENCE WINANT has become Assistant Engineer, Provisional, Public Service Commission, Albany, N.Y. His previous connection was with E. I. du Pont de Nemours and Company.

ERVING M. YOUNG has accepted a position as designer with the Port of New York Authority, to which he comes from the Deslauriers Column Mould Company, Inc., New York, where he was Chief Engineer.

FRANK V. FIELDS, previously Superintendent of the Municipal Water and Light Plant, Mooresville, N.C., has become Branch Manager of the Southern Public Utilities Company, with offices in the same city.

U. B. GILROY is no longer connected with the U.S. Bureau of Fisheries, having become Assistant Engineer with Shirley Baker, Consulting Engineer of Seattle, Wash.

HARRY S. CLYDE has severed his connection as Assistant Engineer with the East Bay Municipal Utility District of Oakland, Calif., to accept a position as Contractor with W. W. Clyde and Company, Springville, Utah.

HERMAN A. JAKOBSSON, Structural Engineer of San Francisco, has recently become Structural Designer with the Shell Oil Company, San Francisco.

RAYMOND J. ROSENBERGER is now connected with the American Road Builders' Association, Washington, D.C. He was formerly with the Highway Engineering Bureau, also of Washington.

JOHN KRAMER FLICK, engineer and contractor of Sudlersville, Md., has accepted a position as Assistant Chief Engineer with the Carretera al Atlantico, Managua, Nicaragua.

JOSEPH HAINES DICKINSON is now President of the United Steel Block Corporation and Manager of the Logging Department of the Lidgerwood Manufacturing Company, Winter Park, Fla.

FRAZIER P. LA BOON has resigned as Inspector, U.S. Engineers, to become Assistant Engineer (civil) with the Interstate Commerce Commission, Washington, D. C.

S. A. HART, formerly Sanitary Engineer for the City of Berkeley, has taken up his duties as Associate Engineer, Supervision of Dams, State of California, Sacramento.

F. WESTERVELT TOOKER has been appointed Office Engineer of the New Jersey State Highway Department, with offices in Newark, N.J.

HORACE C. BOOZ, formerly Chief Engineer of the Berwind-White Coal Mining Company in Wynewood, Pa., is now General Manager of the Berwind Land Company of Philadelphia, Pa.

HOLTON COOK has accepted the position of Resident Engineer for the Fargo Engineering Company of Burnet, Texas.

JAMES L. HARROP, at one time Vice-President of the Public Works Engineering Corporation, 40 Exchange Place, New York, N.Y., now holds the same position with the Trojan Engineering Corporation, at the same address.

WILFORD S. HASSENMILLER is now Structural Engineer for the Shell Oil Company, Shell Building, San Francisco, Calif., having formerly held the same position with the Shell Development Company, Russ Building, in the same city.

WILLIS C. CHRISTOPHER, who was formerly Designing Engineer of the City of Los Angeles, has now accepted a position as Engineer, for the Metropolitan Water District of the same city.

EUGENE J. SHAW is now Chief Engineer of Surveys, Pacific Railroad of Nicaragua, with offices at Managua, Nicaragua. He was previously with A. Guthrie and Company, Inc., Pachacayo, Peru, as Engineer in Charge.

C. D. MEALS, formerly Chief Engineer of the American Cable Company and Wire Rope Engineer of the Roebling Company, has taken charge, as President and General Manager, of the Wire Rope Corporation of America, Inc., New Haven, Conn.

A. F. HAURY, now Vice-President and Treasurer of the Wire Rope Corporation of America, Inc., New Haven, Conn., was formerly connected with the American Cable Company as wire rope engineer, and with the American Steel and Wire Company as draftsman.

G. T. RUDE, Commander, U.S. Coast and Geodetic Survey, has drawn a new assignment as inspector of construction on the Coast and Goedetic Survey vessel, *Hydrographer*, now under construction at Newport News, Va.

WILLIAM S. POST, who, as engineer of construction, has recently completed the Calaveras Dam for the City of Stockton, Calif., has just been appointed Director of Irrigation for the U.S. Indian Service.

A. F. JACOBI has left the employ of Albert Kahn, Inc., Architects and Engineers of Detroit, to become associated again with the Board of Commissioners, Port of New Orleans, La., in the capacity of Designing Engineer.

GEORGE M. PURVER, Consulting Engineer of New York, has been designated Contact Engineer on the Noise Abatement Program for the Board of Transportation of the City of New York.

WILLIAM BARCLAY PARSONS, Construction Engineer of New York City, has been reelected to serve his fifteenth year as chairman of the Board of Trustees of Columbia University.

CAREY H. BROWN, formerly Major, Corps of Engineers, U.S. Army, is now Executive Director of the Rochester Civic Improvement Association, Rochester, N.Y.

H. A. VAN NORMAN has been advanced to the position of Chief Engineer and General Manager of the newly created Department of Water and Power of the City of Los Angeles, which was recently formed by the consolidation of the former water and power bureaus.

M. A. LIPPMAN, who has been engineer for the Kyrock Corporation of New York, has now been appointed the New York, New Jersey, and New England representative of the Kentucky Rock Asphalt Company, Inc., with offices at 11 West 42nd Street, New York, N.Y.

G. H. BLAKELEY, formerly Vice-President of the Bethlehem Steel Corporation, will become president of the McClintic-Marshall Corporation, as announced in conjunction with the agreement to acquire that company by the Bethlehem Steel Corporation.

R. P. CARR has resigned as Technical Assistant to the Chief Engineer of the Electric Bond and Share Company, Santiago, Chile, to become Assistant to the President of the Cia. Constructora del Pacifico, Santiago.

FREDERICK J. CELLARIUS, who was formerly Consulting Engineer with the Cellarius and Shepard Engineering Company of Dayton, Ohio, is now a member of the F. J. Cellarius Engineering Company of the same city.

N. GOSTA PERSON is now connected with Stone and Webster Engineering Corporation, Wenatchee, Wash. He was formerly with the Public Works Engineering Corporation of San Francisco.

JAMES L. FEREBEE has been appointed Chief Engineer both of the Sewerage Commission of the City of Milwaukee and of the Metropolitan Sewerage Commission of the County of Milwaukee. Previously, Mr. Ferebee was Superintendent of Public Works, West Allis, Wis.

T. SCHUYLER HERSEY, formerly Manager, Inspection and Testing Department, Smith Emery and Company of San Francisco, is now Manager of the Hersey Inspection Bureau, Oakland, Calif.

BAYARD F. SNOW has opened offices as Consulting Civil and Sanitary Engineer in Boston; he is also Director, X. Henry Goodnough, Inc. Formerly Mr. Snow was Resident Engineer in the South Essex Sewerage District, Salem, Mass.

T. WILLARD ESPY has resigned as Assistant Chief Engineer of the Spring Valley Water Company of San Francisco to accept an appointment as Engineer of Water Production of the San Francisco Water Department.

JOHN M. THOMPSON, JR. is now located at 120 Broadway, New York, as Consulting Engineer. Previously he was Vice-President and General Manager of the Mexican Telephone and Telegraph Company, City of Mexico.

JOHN T. WHITNEY, formerly Designing Engineer, Bureau of Bridges and Structures, Department of Public Works, Pittsburgh, has been appointed Assistant Engineer in the Department of City Transit of the same city.

Changes in Membership Grades

Additions, Transfers, Reinstatements, Deaths, and Resignations

From January 12 to February 9, 1931

ADDITIONS TO MEMBERSHIP

ADAMS, CYRIL SAMUEL. (Jun., Oct. '30.) Instr., Civ. Eng., Agri. and Mech. Coll. of Texas, College Station, Tex.

ALEXANDER, EDWARD KENNETH. (Jun., Dec. '30.) 111 North 17th St., Terre Haute, Ind.

ANDERSON, EDWARD CAREW. (Jun., Oct. '30.) 2211 East 50th St., Seattle, Wash.

ANDERSON, PAUL OTTO. (Jun., Oct. '30.) 122 Whitmarsh Ave., Worcester, Mass.

ASKEW, DAVID HEARN. (Assoc. M., Dec. '30.) Asst. Res. Engr., State Highway Dept., Court House, Fort Worth, Tex.

BARROWS, DANIEL JOSEPH. (Jun., Dec. '30.) 3601 Connecticut Ave., Washington, D.C.

BARTOCCINI, JAMES FRANCIS. (Jun., Nov. '30.) Care, Bartoccini Bldg. Corp., 160 Fifth Ave., New York, N.Y.

BENNETT, ARCHIBALD. (Assoc. M., Oct. '30.) Sales Engr., Southern Natural Gas Corp., Birmingham, Ala.

BOTTOMS, ERIC EDMUND. (Jun., Nov. '30.) Insp., U.S. Corps of Engrs., Buffalo Dist., 540 Federal Bldg., Buffalo, N.Y.

BORGESON, CLARENCE JOHN. (Assoc. M., Jan. '31.) Office Engr., East Bay Water Co., 512 Sixteenth St., Oakland, Calif.

BROWN, HARRY. (Jun., Oct. '30.) Care, State Highway Dept., Nahunta, Ga.

CARRIER, VIRGIL SAMPSON. (Jun., Oct. '30.) 507 West 1st St., Dixie, Ill.

CHAMPLIN, GEORGE DELONG. (Jun., Oct. '30.) 15 South Ave., Ithaca, N.Y.

CLARK, JOHN ALFRED. (Jun., Dec. '30.) Care, Mrs. Mabel M. Clark, Miss Harker's School, Palo Alto, Calif.

COOK, ROBERT ELTON. (Jun., Oct. '30.) Box 1311, Tucson, Ariz.

CROW, THOMAS OTHO. (Jun., Dec. '30.) Draftsman, Dept. of Public Works, City Hall, Berkeley, Calif.

Crowell, Robert Ashton. (Jun., Oct. '30.) 405 South Broadway, Pasadena, Calif.

Day, Charles Goodwin. (Jun., Dec. '30.) Insp., Day & Zimmerman Eng. & Constr. Co., 112 North Broad St., Philadelphia, Pa.

DeFabritis, Laurence Lamont. (Jun., Jan. '31.) Room 3-238, Mass. Inst. Tech., Cambridge A, Mass.

Dillingham, Marion Alfred. (Jun., Oct. '30.) 5151A Page Boulevard, St. Louis, Mo.

Doughty, Samuel Clifford. (Jun., Dec. '30.) Draftsman, The Port of New York Authority, New York, N.Y.

Earle, Ralph. (Assoc. M., Dec. '30.) Engr., Triest & Earle, Inc., Philadelphia, Pa.

Farmer, Sidney French. (Jun., Dec. '30.) Junior Engr., Port of New York Authority, Fort Lee, N.J.

Fiala, Ernest George. (Jun., Nov. '30.) Asst. San. Engr., State Dept. of Health, Des Moines, Iowa.

Filby, Ellsworth Lincoln. (Assoc. M., Jan. '31.) Chf. Engr., State Board of Health, Box 4479, Jacksonville, Fla.

Fitzgerald, Edmund Landers. (Jun., Dec. '30.) 566 Eleventh Ave., San Francisco, Calif.

Fuellhart, Donald Egbert. (Assoc. M., Jan. '31.) Engr., Brokaw, Dixon, Garner & McKee, 405 Fairfax Bldg., Kansas City, Mo.

Fuller, Purl. (Assoc. M., Aug. '30.) Asst. Civ. Engr., City of Los Angeles, Los Angeles, Calif.

Gidlow, William. (Jun., Dec. '30.) Rodman, Montauk Beach Development Co., Box, 823, Montauk, N.Y.

Gilbert, Harold Hurlbut. (M., Oct. '30.) Bridge Designer, State Highway Dept., R. F. D. 4, Box 107, Olympia, Wash.

Hahn, Edward Milton. (Jun., Dec. '30.) 348 West Packard Ave., Fort Wayne, Ind.

Hanlon, William Burns. (Jun., Dec. '30.) Junior Engr., U.S. Geological Survey, 506 Broadway-Arcade Bldg., Albany, N.Y.

Hedefine, Alfred. (Jun., Jan. '31.) Graduate Research Asst., Univ. of Illinois, Urbana, Ill.

Hill, Henry Osborne. (Jun., Dec. '30.) Junior Civ. Engr., U.S. Dept. of Agriculture, Box 403, Tyle., Tex.

Hollick, Robert Ebenezer. (Jun., Dec. '30.) With McClintic-Marshall Constr. Co., 916 South Ave., Wilkinsburg, Pa.

Holzbaur, Arthur Alan. (Jun., Nov. '30.) With McClintic-Marshall Constr. Co., Pottstown, Pa.

Houston, David Tullis. (Jun., Dec. '30.) Asst. Job Engr., Marc Eidlitz & Son, New York, N.Y.

Hull, William Janney. (Jun., Jan. '31.) Draftsman, Water Bureau, Hartford, Conn.

Humphreys, Marion, Jr. (Jun., Oct. '30.) 1220 South 6th St., Springfield, Ill.

Hurley, John William. (Jun., Jan. '31.) R. S. O. Barracks, U.S. Naval Air Station, Pensacola, Fla.

Ingraham, Richard William. (Jun., Nov. '30.) Asst. Insp. of Constr., Navy Yard, Mare Island, Calif.

Jeffers, Orison Herdman. (Jun., Dec. '30.) 1156 Fifteenth St., N.W., Washington, D.C.

Johnson, Philip Ellsworth. (Assoc. M., Aug. '30.) Engr.-Salesman, Soulé Steel Co., Rialto Bldg., San Francisco, Calif.

Johnston, Clair Crawford. (Jun., Oct. '30.) Instr., Civ. Eng., Univ. of Detroit, Detroit, Mich.

Kalman, Eugene. (M., Dec. '30.) Visiting Prof. Civ. Eng., California Inst. of Technology, Pasadena, Calif.

Kelley, Bond Taylor. (Jun., Oct. '30.) 7918 Kingsbury, St. Louis, Mo.

Kieran, John Joseph James. (Jun., Jan. '31.) Eng. Asst., Board of Transportation, New York, N.Y.

King, Donald Dominick. (Jun., Nov. '30.) Care, Am. Soc. C.E., 33 West 39th St., New York, N.Y.

Kolberk, Andrew. (M., Oct. '30.) Designer Board of Water Supply, New York, N.Y.

Kosowsky, Jack Lee. (Jun., Oct. '30.) Junior Civ. Engr., Bureau of Valuation, Interstate Commerce Comm., Washington, D.C.

Lange, Bernice. (Jun., Aug. '30.) 1205 North 46th St., Seattle, Wash.

Lawrence, Robert Landy, Jr. (Assoc. M., Nov. '30.) Engr. and Draftsman, Water Works Dept., City Hall, Nashville, Tenn.

Leone, Nicholas. (Jun., Nov. '30.) Junior Asst. Engr., Grade II, State Highway Dept., Box 161, North Collins, N.Y.

Lightfoot, Harold Counsel. (Assoc. M., July '30.) Squad Boss, United Engrs. & Constructors, U.G.I. Bldg., Philadelphia, Pa.

Lindman, Bertram Herman. (Jun., Jan. '31.) Eng. Aide, Bureau of Valuation, Interstate Commerce Comm., Washington, D.C.

Lingley, Ralph Grearson. (Assoc. M., Dec. '30.) City Engr., Room 33, City Hall, Worcester, Mass.

Lowe, Thomas Marvel. (Assoc. M., Jan. '31.) Asst. Prof., Civ. Eng., Univ. of Florida, Gainesville, Fla.

McKeen, William Otho. (Jun., Dec. '30.) 915 Sixteenth Ave., North, Seattle, Wash.

McKinstry, Thomas Bates. (Jun., Nov. '30.) Room 429, Customs Bldg., San Francisco, Calif.

Magney, Gottlieb Renatus. (M., Nov. '30.) Archt. and Engr., Magney & Tusler, Inc., 104 South 9th St., Minneapolis, Minn.

Marple, Garland Emmett. (Jun., Nov. '30.) Care, Div. of Management, Bureau of Public Roads, Washington, D.C.

Mejia, Julio Ernesto. (Assoc. M., Dec. '30.) Assoc. Prof. of Mathematics, School of Eng., Univ. of El Salvador, San Salvador, Salvador.

Messer, Roy Thomas. (Jun., Oct. '30.) 1221 Kellogg Ave., Ames, Iowa.

Mills, Eugene Clarence. (M., Dec. '30.) 639 San Fernando Ave., Berkeley, Calif.

Morehouse, Stanley Embleton. (Jun., Aug. '30.) Field Engr., Kimberly-Clark Co.) Neenah, Wis.

Muckel, Dean Christner. (Jun., Oct. '30. Y. M. C. A., Santa Ana, Calif.

Niederhoff, August Evan. (Jun., Oct. '30.) 333 North Michigan Ave., Room 1325, Chicago, Ill.

Nisula, John Frederick. (Jun., Dec. '30.) 234 Medbury Ave., Detroit, Mich.

Nordberg, Bror. (Jun., Dec. '30.) 1119 Maple Ave., Evanston, Ill.

Owens, James. (Jun., Jan. '31.) Equipment Supervisor, Mexican Petroleum Corp., 11 Hill St., Newark, N.J.

Peugh, Verne Leon. (Assoc. M., Dec. '30.) Field Engr., Pasadena Water Dept., 2835 Pina del Vista Drive, Altadena, Calif.

Prior, Charles Henry. (Jun., Jan. '31.) Junior Hydr. Engr., U.S. Geological Survey Tuscaloosa, Ala.

Remp, Richard William. (Assoc. M., July '30.) Supt., Dravo Contr. Co., Water Works Park, Detroit, Mich.

Robinson, Ralph Raymond. (Jun., Dec. '30.) 317 Centre Ave., Delanco, N.J.

Rogde, Sigurd Olai. (Assoc. M., July '30.) Civ. Engr., Anglo-Chilean Nitrate Co., 120 Broadway, New York, N.Y.

Rosenberg, William Charles. (Jun., Jan. '31.) 265 Eighth St., Hoboken, N.J.

Sailer, William Paul. (Jun., Dec. '30.) 5909 Camac St., Philadelphia, Pa.

Sawyer, Leon Randolph. (Jun., Dec. '30.) Care, U.S. Geological Survey, Room 303, Interior Bldg., Washington, D.C.

Scott, Robert Graham. (Assoc. M., Dec. '30.) Dist. Engr., E. T. Archer & Co., Box 141, Magnolia, Ark.

Shawl, Harold. (Jun., Dec. '30.) Asst. Engr., Wutchumna Water Co., 211 East Mineral King Ave., Visalia, Calif.

Smutz, Huber Earl. (Jun., Dec. '30.) Zoning Engr., Dept. of City Planning, Room 361, City Hall, Los Angeles, Calif.

Stodolski, Walter Alexander. (Jun., Nov. '30.) 479 West Hanover St., Trenton, N.J.

Stolley, Bruno. (Jun., Dec. '30.) 630 Napoleon Ave., New Orleans, La.

Strong, Charles Arthur. (M., Oct. '30.) Director, Pacific Engrs., Ltd.; Pres., Strong & Macdonald, Inc., 1020 Puget Sound Bank Bldg., Tacoma, Wash.

Summerlin, John Vandergrift. (Jun., Jan. '31.) Care, E. Tucker Carlton, 1207 West Franklin St., Richmond, Va.

Sweeney, John. (M., Dec. '30.) Cons. Engr., 5837 Lexington Ave., Los Angeles, Calif.

Teller, Carl Freeman. (Assoc. M., Aug. '30.) Asst. Res. Engr., State Highway Dept., Box 489, Amarillo, Tex.

Thomas, Lovic Pierce, Jr. (Jun., Nov. '30.) Insp., Corps. of Engrs., U.S.A., Vicksburg Dist., Box 143, Glen Allan, Miss.

Vokac, Roland. (Assoc. M., Nov. '30.) With State Highway Dept., Ann Arbor, Mich.

Wagner, John Forest. (Jun., Dec. '30.) 138 Fir Hill, Akron, Ohio.

Wicks, Samuel Stanley. (Jun., Oct. '30.) Junior Engr., Dept. of Interior, Bureau of Reclamation, 1441 Welton St., Denver, Colo.

Membership Transfers

Beach, William Ernst. (Assoc. M., '23; M., Jan. '21.) Care, V. D. Simons, Inc., 2015 Tribune Tower, Chicago, Ill.

Carney, George Francis. (Jun., '25; Assoc. M., Nov. '30.) Sales Engr., Truscon Steel Co., San Francisco, Calif.

Chase, Arthur Sloan. (Jun. '27; Assoc. M., Aug. '30.) Care, J. M. Whitehead, Jonesville, S.C.

Childs, Fred Samuel. (Assoc. M., '25; M., Jan. '31.) Prin. Engr., George A. Johnson, 150 Nassau St., Room 1133, New York, N.Y.

Collings, William Tatem, Jr. (Assoc. M., '23; M., Jan. '31.) Engr., Imperial Irrig. Dist. Imperial, Calif.

Coote, Charles Warren. (Jun., '28; Assoc. M., Nov. '30.) Structural Draftsman, Board of Transportation, Div. of Designs, 250 Hudson St., New York, N.Y.

Foulke, Charles Leslie. (Assoc. M., '20; M., Dec. '30.) Civ. and Structural Engr., 455 Fourth St., San Bernardino, Calif.

Francis, Ernest David. (Assoc. M., '24; M., Jan. '31.) Associate, Weeks & Day, Financial Center Bldg., San Francisco, Calif.

Freeman, Orville William. (Jun., '26; Assoc. M., Jan. '31.) Constr. Supt., S. S. Kresge Co., 2727 Second Boulevard, Detroit, Mich.

Haupt, Caspar Wister. (Assoc. M., '21; M., Jan. '31.) Vice-Pres., Strobel Steel Constr. Co., 53 Jackson Boulevard, Chicago, Ill.

Hill, Byron Arthur. (Jun., '28; Assoc. M., Nov. '30.) Bldg. Insp., California Inst. of Technology, Pasadena, Calif.

Hopper, Clarence Ricker. (Assoc. M., '20; M., Dec. '30.) Gen. Contr., 433 Meriwether St., Griffin, Ga.

Israelsen, Orson Winso. (Assoc. M., '26; M., Dec. '30.) Prof., Irrig. and Drainage Eng., Utah State Agri. Coll., Logan, Utah.

Kellam, Fred. (Assoc. M., '21; M., Jan. '31.) Asst. Chf. Engr., State Highway Comm., Indianapolis, Ind.

Kidder, Harold Halsey. (Assoc. M., '28; M., Dec. '30.) Chf. Engr., Irrig. and Drainage Impvt., Hidalgo County Water Impvt. Dist., No. 2, San Juan, Tex.

Long, Milo Smith. (Assoc. M., '20; M., Jan. '31.) Supt., Miscellaneous Constr., Allied Engrs., Inc., 600 North 18th St., Birmingham, Ala.

Marcus, Bernard. (Jun., '23; Assoc. M., Dec. '30.) Asst. Engr., The Board of Water Supply, 32-14 Broadway, Astoria, N.Y.

Mayer, Louis Carl. (Assoc. M., '27; M., Jan. '31.) Asst. San. Engr., City Engr's Office, 749 City Hall, Los Angeles, Calif.

Mellema, William. (Assoc. M., '20; M., Jan. '31.) Archt., Cons. Engr. and Mgr. of Constr., 1709 West 8th St., Room 422, Los Angeles, Calif.

Munson, Spencer Munroe. (Jun., '25; Assoc. M., Jan. '31.) Asst. Hydr. Engr., State Div. of Water Resources, 401 Public Works Bldg., Sacramento, Calif.

Parker, Granville. (Jun., '26; Assoc. M., Dec. '30.) Care, T. D. Ortiz, Gacel 50, Altos, Cienfuegos, Cuba.

RUDOLPH, ROY FRANCIS. (Assoc. M., '25; M., Jan. '31.) Superv. Engr., Union County, Box 276, New Albany, Miss.

SCHMIDTMAN, EDWARD HERMAN. (Jun., '23; Assoc. M., Jan. '31.) Supervisor, Special Investigations, Research Bureau, The Milwaukee Elec. Ry. & Light Co., Milwaukee, Wis.

WISSING, JOHN LEE. (Assoc. M., '26; M., Jan. '31.) Senior Engr., Office of County Engr., Bergen County, Hackensack, N.J.

ZWANZIGER, DAVID MENDEL. (Jun., '27; Assoc. M., Oct. '30.) Civ. Engr., Mideastern Contr. Corp., 9 Jackson Ave., Long Island City, N.Y.

REINSTATEMENTS

GUERDRUM, GEORGE HAGBART, Assoc. M., re instated Jan. '31.

KOENIG, OSKAR PAUL, Jun., reinstated Feb. '31.

RESIGNATIONS

ALBERT, FRANK MEYER, Assoc. M., resigned Feb. '31.

DAY, JOHN CHARAVELLE, Assoc. M., resigned Jan. '31.

DEVLIN, JOHN JOSEPH, Assoc. M., resigned Feb. '31.

HOWELL, LESLIE DILLON, M., resigned Jan. '31.

MOTTIER, CHARLES HELVETIUS, M., resigned Jan. '31.

ROBB, JAMES HOWARD, M., resigned Feb. '31.

ROBERTSON, ALEXANDER KING, M., resigned Jan. '31.

ROBEY, WALTER EARL, Jun., resigned Jan. '31.

ROSS-CLUNIS, HAYDEN, Jun., resigned Jan. '31.

SCHNEIDER, FLOYD EDWARD GEORGE PAUL, Jun., resigned Jan. '31.

SCOTT, CHARLES BRUCE, M., resigned Jan. '31.

TAYLOR, WILLIAM PURVES, Assoc. M., resigned Jan. '31.

DEATHS

ALLEN, KENNETH. Elected M., May 2, 1888; died Sept. 7, 1930.

BOWMAN, CHARLES ABEL. Elected M., Nov. 1, 1905; died Jan. 23, 1931.

FARNSWORTH, HOWARD RICHARDS. Elected Assoc. M., Apr. 17, 1917; M., Jan. 14, 1924; died Feb. 6, 1931.

HAWGOOD, HARRY. Elected M., May 4, 1909; Director 1918–1920; died Jan. 3, 1931.

LUIGGI, LUIGI. Elected M., Feb. 7, 1906; Hon. M., Oct. 10, 1921; died Feb. 1, 1931.

METCALFE, JOSEPH DAVIS. Elected Assoc. M., Apr. 2, 1913, M., Oct. 22, 1924; died Feb. 2, 1931.

MONCREIFF, JOHN MITCHELL. Elected M., Nov. 3, 1897; died Jan. 10, 1931.

READ, HENRY ENGLISH. Elected Assoc. M., Apr. 12, 1926; died Jan. 26, 1931.

RIPLEY, HENRY CLAY. Elected M., Oct. 7, 1896; died Jan. 9, 1931.

SHAMBAY, MICHAEL JACOBS. Elected M., Oct. 14, 1930; died Dec. 24, 1930.

WEBSTER, GEORGE SMEDLEY. Elected Assoc. M., Sept. 7, 1892; M., Oct. 4, 1893; Director, 1904–1906; Vice-President, 1917–1918; died Jan. 23, 1931.

TOTAL MEMBERSHIP AS OF FEBRUARY 9, 1931

Members	5,828
Associate Members	6,196
Corporate Members	12,024
Honorary	16
Juniors	2,593
Affiliates	134
Fellows	7
Total	14,774

Men and Positions Available

These items are from information furnished by the Engineering Societies Employment Service with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fees is to be found on page 87 of the 1930 Year Book of the Society. Unless otherwise noted, replies should be addressed to the key number, Engineering Societies Employment Service, 31 West 39th Street, New York, N.Y.

CIVIL ENGINEER; American; 25; single; three years university work in engineering. Four years experience laying double tracks, puzzle switches, cross-overs, running levels, and transit work with railroad. Tropical experience in topography, railroad bridge construction, drafting and plotting contour maps. Available at once. Will go anywhere. References. C-7443.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 47; married; technical graduate. Four years experience in structural design of wide variety of buildings and other structures. Three years supervision (inspection) of construction of reinforced concrete buildings and other structures; two years hydrographic work and surveying. Location Southwest. C-8649-311-A-3. San Francisco.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 37; 15 years experience designing, estimating, and pricing all items of general contracts, purchasing all materials, expediting and supervising construction of all types of buildings. Available at once at reasonable salary as project manager, estimator, expediter, or construction superintendent. B-4964.

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; age 31; married; desires responsible position. Ten years broad experience structural design on railroad viaduct and station, elevated streets, industrial buildings, bins, conveyor galleries, bridges, cement and coke oven plants, also foundations. Now employed as squad leader. C-8644.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; licensed professional engineer; 34; married. Ten years experience, designing of steel and reinforced concrete, construction of high-class structures, such as, tall office buildings, garages, and theatres. Desires position with leading architects, engineers, or contractors. Excellent references. Available immediately for United States. C-6335.

CIVIL AND CONSTRUCTION ENGINEER; M. Am. Soc. C.E.; age 49; married; 25 years experience in design, construction, valuation, estimating, foundation problems, reports, reconnaissance, and locating. Has been employed by railroads, contractors, states, industrial firms, and owners. Interested in similar connections. B-4802.

ENGINEER; Assoc. M. Am. Soc. C.E.; 35; married; Cornell graduate, 1921; New York State license. Good contacts with all classes of contractors through western New York. Five years general construction experience; four years sale and promotional experience. Desires position as sales engineer with equipment company or medium-sized contracting outfit. C-7879.

HYDRAULIC ENGINEER; Jun. Am. Soc. C.E.; B.E.; M.S.; age 27; married. Five years experience in hydraulic investigation and design embracing hydro-electric, drainage, flood-control, and irrigation projects. Desires position with future. Location immaterial. C-4172.

RECENT GRADUATE; Jun. Am. Soc. C.E.; 22; single. Graduate Worcester Polytechnic Institute, 1930; one summer's experience drafting for stone quarry company. With power company on power development work, since graduation. Unemployed at present. Excellent references. Ambitious; willing to try anything which offers possibility of advancement. Location immaterial. C-8660.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; graduate Massachusetts Institute of Technology; desires executive position; 17 years with one company, nation-wide in operation; 12 of these years as Pacific Coast manager engaged in designing and erecting fireproof buildings. Developed business, made sales and investment analyses, and directed organization. C-8697.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; age 26; married; two years general surveying and office work with public utility and railroad; three years field engineering on dam and power house construction. Desires position with construction or engineering firm. Available at once. Location eastern United States. C-3182.

YOUNG CIVIL ENGINEERING GRADUATE; desires position as engineering sales representative for local or foreign service; age 24; single, good appearance. Five years of engineering experience, confined chiefly to municipal construction work; also extensive executive and sales experience. Understands uses and possibilities of construction equipment. Can furnish good references. C-7322.

CIVIL ENGINEER; graduate; age 27; single; 5 years experience designing and detailing reinforced concrete and steel in building construction. One year as instructor, concrete design, in New York college (evenings). Thoroughly familiar with concrete. Desires connection with contractor, consulting engineer, bar company. Location, New York City or metropolitan district. C-895.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 29; married; eight years experience in design and construction; four of these on design of highway bridges and viaducts. Experienced on statically indeterminate frames and arches. Available on three weeks notice. C-3357.

CIVIL ENGINEERING GRADUATE; Jun. Am. Soc. C.E.; age 25; single; 17 months tropical experience in topographical surveying and drafting, location and construction of irrigation canals and drains. Desires work on location and construction of highways or railroads. Location immaterial. Available on short notice. C-6144.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 31; single; graduate Purdue University, 1926. Five years experience research work with portland cement and concrete in laboratories of large organizations. Excellent references from present and former employers. Desires location in vicinity of New York City, but will go anywhere. C-8698.

CIVIL ENGINEERING GRADUATE; three years out of school. Two years experience on construction, handling materials, organization, equipment scheduling, progress reports, and progress photography; one year steam turbine calculations. Suitable references. Location preferred South or East. Available immediately. C-8485.

DREDGING EXECUTIVE AND ENGINEER; M. Am. Soc. C.E.; 20 years highly specialized experience designing, building, and operating all sizes and types of hydraulic, dipper, and clamshell dredges. Complete charge many extensive projects on inland and tidal waters. Open for domestic or foreign engagement. C-5085.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; New Jersey registration; 40; married; 18 years experience as engineer, estimator, superintendent, executive in charge sewers, state road work, subways, barge canal, buildings all types. Thoroughly qualified to take responsible charge. Excellent knowledge costs and modern methods of construction. Available at once. C-4211.

GRADUATE CIVIL ENGINEER; three year experience, state engineering and highway department, steel and concrete design buildings and bridges; highway inspector; eight years with leading public utility company; two years de-

sign; four years charge of 40 to 70 draftsmens and two years assistant engineer, directing design, writing specifications, and purchasing material. C-8770.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 30; married; one year teaching structural engineering; seven years general practice; forest, municipal, highway, industrial engineering. Design and construction of pulp and paper mills, steam and hydro-electric power plants, flood control, drainage, water supply, sanitary engineering. Available immediately. Location immaterial. C-8715.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; construction assistant superintendent. Responsibly in charge of construction of 25 miles railroad; designed construction of three reinforced concrete bridges, semi-hard surfaced streets, roads, sewer system. Drainage 10,000 acres. In charge crew, graphical coordinate calculations, developing 30,000 acres. Transmission line construction; good draftsman. Two years college; eight years experience; 30; single. Knowledge Spanish. C-7063.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; Michigan graduate; 30; married; five years railroad and highway experience on surveys. Responsible charge of construction; three years in charge of design of buildings, bridges, and purchasing materials; desires position where ability to grow can be utilized to mutual advantage; location immaterial. C-4108.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 25; B.S. and C.E. degrees. Speaks fluent German; last one and one-half years field engineer at concrete building construction with general contractor; previously with architect; desires position with contractor, engineer, or architect, field or office. New York City location preferred. Available immediately. C-8681.

CIVIL ENGINEER; ten years experience, design and construction of sewerage systems, water supplies, and municipal improvement. Engineering and construction supervision on power house, bridge, theatre, warehouse, and hotel. Licensed civil engineer and land surveyor. C-6649.

CIVIL ENGINEER; New York State license; ten years experience in designing tall office buildings, theatres, apartment houses, and various industrial buildings. Six years chief designer in charge of designing department. A-5454.

CIVIL ENGINEER; M. Am. Soc. C.E.; 28 years experience on railways, water works, sewers, lighting plants, industrial maintenance, construction, dock construction, pile bridges, valuation, and appraisals, including management. Recently 3 years in South America. Desires connection with industry, utility, or railway. Registered engineer, Colorado. C-8695.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; registered professional engineer; college graduate. Ten years comprehensive experience design and construction industrial plants, river improvements, and municipal projects; has taught college courses in engineering. Desires teaching or similar position affording some opportunity for personal study. At present employed; available reasonable notice. C-7235.

CIVIL ENGINEER; M. Am. Soc. C.E.; degree in civil engineering; 35 years varied experience, railroad, preliminary location, and construction. General practice, industrial and municipal. For past 10 years on highway, reinforced concrete pavement, survey, preliminary location, and construction. Desires inside work on plans, estimates, and design, as outlined above. B-5309.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; B.S.; C.E., 1929; age 24; 14 months experience on railroad location as topographer, draftsman, and office man. Estimates and comparisons. East of Mississippi River. C-8696.

JUNIOR ENGINEER OR INSTRUMENTMAN; 28; married. One year, A.B.; two years, C.E.; two years reinforced concrete, instrumentman and party chief on mining, highway, railroad, and miscellaneous surveys and construction. Considerable reinforced concrete construction experience as assistant and inspector. Total field experience of six years. C-8022.

CIVIL ENGINEER; M. Am. Soc. C.E.; 30 years experience United States, Europe, Spanish America, preliminary survey, design, construction, management public works, including canals, harbors, railroad construction, municipal work, highways. Recently completed water-supply sewerage, paving tropical city foreign government. Open for engagement any country where ability and tact are requisites. Speaks and writes, French and Spanish. B-5519.

CIVIL ENGINEER; M. Am. Soc. C.E.; wide experience municipal water supply, watershed to consumer. Run-off; topographic surveys; design and construction of large masonry and earthen dams. Ten years on power developments. Four years design and construction of wharves, piers, seawalls, dredging, and hydrographic surveys. Registered professional engineer, Michigan, New York, North Carolina. A-914.

UNIVERSITY INSTRUCTOR; Jun. Am. Soc. C.E.; age 23; graduate of Brooklyn Polytechnic Institute; will complete work for M.S. degree in sanitary engineering in June; two years experience as part-time instructor and assistant in civil engineering. Desires instructorship in civil or sanitary engineering. Available July 1st. C-4700.

CIVIL AND HYDRAULIC ENGINEER; M. Am. Soc. C.E.; 50; married; varied experience on railroad location, construction, Latin America, river and harbor fortification, U.S. Government, and industrial building. Ten years with public utilities, design, investigation, hydro, steam, and Diesel plants. Speaks Spanish. Responsible position, United States or foreign country. Now available. B-4209.

ENGINEER EXECUTIVE; Assoc. M. Am. Soc. C.E.; European graduate; 35; 12 years construction experience in design and construction of European and United States steel and concrete, wharves and industrial structures. Two years as chief engineer for large American firm. Past five years operating independently as industrial engineer. Desires to represent American firm in Europe. C-8659.

RECENT BOOKS

New books of interest to Civil Engineers, recently donated by the publishers to the Engineering Societies Library, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on pages 77 and 78 of the Year Book for 1930. The statements made regarding the books are taken from the books themselves and this Society is not responsible for them.

AN INTRODUCTION TO REGIONAL SURVEYING. By C. C. Fagg and G. E. Hutchings. Cambridge, England, University Press, 1930. American Agents, New York, Macmillan Co. 150 pp., illus., diagrs., maps, 9 × 6 in., cloth. $3.00.

A regional survey is the organized study of a geographical area and its inhabitants—plant, animal, and human—from every aspect, and the correlation of all aspects so as to present a complete picture of the region. This manual is intended to give practical guidance in the organization and carrying out of such surveys over small areas, for the guidance of those interested in the subject for its own sake, and of teachers who wish to use regional investigations as an educational instrument.

CLAY PRODUCTS MANUAL. By Clay Products Institute of California. Los Angeles, The Institute, 1930. Various paging, illus., tables, 7 × 4 in., fabrikoid. $3.00.

This convenient pocket volume brings together the information upon clay products commonly wanted by engineers and builders. Mortar, brick, load-bearing and partition tile, terra cotta, roof tile, chimneys and gas vents, sewer pipe, and drain tile are treated. The uses of each product, the results of tests and investigations, and specifications for use are given, based on the recommendations of the Bureau of Standards, trade associations, and other authorities.

ELEMENTS OF WATER BACTERIOLOGY, WITH SPECIAL REFERENCE TO SANITARY WATER ANALYSIS. By Samuel Cate Prescott and Charles-Edward A. Winslow. 5th edition. New York, John Wiley & Sons, 1931. 219 pp., tables, 9 × 6 in., cloth. $2.50.

This edition follows that of 1924 in general, but new procedures of value have been introduced and the extensive bibliography has been brought up to date. The book has long been valued as a guide to the best American practice arranged to meet the needs of sanitary engineers, public hygienists, and others interested in water and sewage problems.

ESTIMATING AND COST KEEPING FOR CONCRETE STRUCTURES. By A. E. Wynn. London, Concrete Publications, Limited, 1930. 258 pp., illus., diagrs., tables, cloth.

This book shows how cost information can be obtained and applied in preparing a tender. Dealing mainly with reinforced concrete construction, it tends to lessen the hazard of the contracting business.

ESTIMATING BUILDING COSTS. By Charles F. Dingman. 2d edition. New York, McGraw-Hill Book Co., 1931. 277 pp., tables, 7 × 4 in., fabrikoid. $2.50.

In preparing the new edition of this work the author has taken into account the changes in building methods, such as the motorization of haulage, the increasing use of excavating machinery and portable electric tools, and the use of the cement-water ratio. New chapters have been added upon interior tile and marble work, foundation work, and cement-gun work.

GRUNDWASSERABSENKUNG BEI FUNDIERUNGSARBEITEN. By Wilhelm Kyrieleis. 2nd edition revised by Willy Sichardt. Berlin, Julius Springer, 1930. 286 pp., illus., plates, diagrs., tables, 9 × 6 in., bound. 22, 50 r.m.

A thorough treatise on methods of lowering the ground water, as practiced in foundation work for docks, locks, and similar structures in Europe. The subject is treated theoretically and practically, the methods and machinery are described, and there are descriptions of a number of illustrative undertakings.

GUIDE DU TECHNICIEN POUR L'ORGANISATION DU TRAVAIL PERSONNEL. By J. Rousset. Paris, Ch. Béranger, 1930. 192 pp., illus., 10 × 6 in., cloth. 62.50 fr.

This unusual book is a guide to the collection and utilization of information, for the benefit of engineers. The author discusses the collection and classification of notes and documents, the organization of libraries, the use of reference libraries, the writing of articles, book publishing, and a number of related topics. Much practical, sound advice is given, which is not collected elsewhere.

HIGHWAY ECONOMICS. By Sigvald Johannesson. New York, McGraw-Hill Book Co., 1931. 157 pp., illus., tables, 9 × 6 in., cloth. $2.50.

An introduction to the economics of highway construction which aims to present principles and methods by which the cost of producing a finished highway may be determined, and also the cost of operating it. Among the topics treated are the cost of vehicle operation upon highways, the cost of delays, the loss of time by interruptions of traffic, highway capacity, grade crossing elimination, economic studies, and traffic surveys.

LAND DRAINAGE AND FLOOD PROTECTION. By Bernard A. Etcheverry. New York, McGraw-Hill Book Co., 1931. 327 pp., illus., diagrs., tables, 9 × 6 in., cloth. $3.00.

A college text on drainage, which will also be useful to engineers and officials of reclamation and drainage districts. The book treats of the surface drainage and underdrainage of agricultural lands affected by excess water, of the protection of lands against flood and tide waters, and of the methods of apportioning the cost of improvements over the areas benefited. The author has endeavored to emphasize fundamental theories and principles of design.

VERSUCHE ZUR ERMITTLUNG DER KNICKSPANNUNGEN FÜR VERSCHIEDENE BAUSTÄHLE. By W. Rein. (Berichte des Ausschusses für Versuche im Stahlbau, ausgabe B, heft 4.) Berlin, Julius Springer, 1930. 55 pp., illus., diagrs., tables, 11 × 8 in., paper. 6 r.m.

This report on the buckling of structural steel presents the results of an elaborate research which has been in progress for almost ten years, under the direction of a large committee of eminent engineers. The methods used are given in detail, with the results of the actual tests and general conclusions.


AMBASSADOR BRIDGE
Longest Suspension Bridge in the World
DETROIT, MICH. to SANDWICH, ONT.
21,000 TONS OF STEEL
Built by
McClintic-Marshall

CURRENT PERIODICAL LITERATURE

Abstracts of Articles on Civil Engineering Subjects from Magazines in This Country and in Foreign Lands

Selected items from the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies Library, one of the leading technical libraries of the world. Some 1,800 technical publications are received by the Library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own files, from your local library, or direct from the publisher. Photoprints will be supplied by this Library at the cost of reproduction, 25 cents per page, or technical translations of the complete text may be obtained when necessary at cost.

BRIDGES

CANTILEVER. Primitive Cantilever Bridge in British Columbia. *Engineering (Lond.)*, vol. 130, no. 3388, Dec. 19, 1930, p. 790, 1 fig. Unique example of bridge construction, which did service for 50 years, made by aboriginal Indians; clear span was 150 ft., and pathway 6 ft. wide, abutments being 100 ft. above water level; it was originally true cantilever, but later strengthened with scrap telegraph wire, until it was mixture of cantilever and suspension types.

CONCRETE. Trend in Design and Construction of Concrete Bridge. *Contract Rec. (Toronto)*, vol. 44, no. 53, Dec. 31, 1930, pp. 1621–1622, 3 figs. Brief review of trends during 1930; employment of long span arches.

CONCRETE ARCH, CONSTRUCTION. Three Cableways and Precast Units Speed Winter Bridge Construction, B. A. Wilder. *Eng. News-Rec.*, vol. 106, no. 2, Jan. 8, 1931, pp. 64–65, 9 figs. Construction of concrete arch bridge costing \$300,000 across Androscoggin River, at Rumford, Me., in 45 weeks, by using separate cableway for each arch rib; units difficult to mold in place were precast and set in cold weather when pouring was stopped; building strong concrete pier and steel-girder substructure to hold arch centers secure in swift floodwaters; arch spans are 85 ft., 200 ft., and 105 ft. long.

CONCRETE, DESIGN. Bridges of Rolled Steel Joists and Concrete, G. H. Hargreaves. *Surveyor*, vol. 79, no. 2032, Jan. 2, 1931, pp. 3–5, 7 figs. Principles of design including graphical charts; minimum depth of joist and concrete; example of design; check on design; arrangement of reinforcement; design with reinforced slab.

CONCRETE GIRDER. North Bathurst Street Bridge, Toronto, W. D. Proctor. *Can. Engr. (Toronto)*, vol. 59, no. 27, Dec. 30, 1930, pp. 745–748, 7 figs. Bridge proper spans 415 ft. from abutment to abutment consisting of five spans of 83 ft.; two end spans having rocker posts; concrete deck is carried on four rows of plate girders spaced at 14 ft. 6-in. centers; provision for future double-track car line; clear distance between curbs is 46 ft.; there are double curbs and two sidewalks of 6 ft. clear width; lower curb has height of 7 in. and upper one of 6 in.

CONCRETE SLABS, PRECAST. Precast Light-Weight Concrete Slabs Bridge Floor Problem. *Concrete*, vol. 38, no. 1, Jan. 1931, pp. 15–17, 3 figs. Large precast slabs of light-weight concrete welded to steel floor system, developed by Division of Bridges of City of Chicago; slabs cast under electric vibration; great strength in 24 hours with high-early-strength cement; details of largest roadway slab.

CONSTRUCTION. Steel and Concrete Bridge Materials, P. J. Freeman. *Can. Engr.*, vol. 60, no. 1, Jan. 6, 1931, pp. 19–22. Control of materials in construction of bridges; activities of bureau of tests of Allegheny County; specifications. Paper presented at annual convention of Am. Inst. Steel Construction.

CONSTRUCTION, WELDING. Welding in Bridge Work. *Ry. Eng. and Maintenance*, vol. 27, no. 1, Jan. 1931, pp. 42–43, 1 fig. Bridge and Building Assn. considers application of electric welding steel structures; presentation of paper, Strengthening a Bridge by Arc Welding Process, by W. R. Roof, and discussion.

HIGHWAY, TORONTO. Composite Design for Bathurst Street Bridge, Toronto. *Contract Rec.*, vol. 45, no. 3, Jan. 21, 1931, pp. 49–50, 2 figs. Structure, now under construction, comprises 203-ft. truss span; two half-through plate girder spans totaling 195 ft., five reinforced-concrete deck spans on concrete bents totaling 141 ft. 8 in., one-half through plate girder span of 46 ft., and reinforced-concrete trough 344 ft. 8 in. long, followed by fill 119 ft. in extent; total length of structure will be nearly 1,100 ft.

STEEL ARCH, KILL VAN KULL. The \$16,000,000 Kill van Kull Bridge. *Eng. and Contracting*, vol. 69, no. 8, Aug. 1930, pp. 285–289, 4 figs. Construction features of 1,675-ft. steel arch between Bayonne, N.J., and Port Richmond, N.Y.

SUSPENSION, CABLES. Investigation of Cold-Drawn Bridge Wire, L. S. Moisseiff. *Am. Soc. Testing Matls.—Proc.*, vol. 30, pt. 2, June 23–27, 1930, pp. 313–347, and (discussion) 348–349, 15 figs. Wire was used for Detroit River Bridge with span of 1,850 ft. and Mount Hope Bridge of 1,200-ft. span; contractor for these bridges, McClintic-Marshall Co., organized series of tests of wire; tests were made at Lehigh University.

SUSPENSION, MULTIPLE SPAN. Multiple-Span Suspension Bridges, E. F. Keuster. *Eng. News-Rec.*, vol. 106, no. 3, Jan. 15, 1931, pp. 102–104, 3 figs. Possibilities and advantages of using horizontal tie cables between tower tops to limit deflection from unbalanced loads; tie cables limit deflection from unbalanced loads and depend for their proper functioning upon considerable amount of press-stressing; deflections at center of loaded span for various layouts; arches used for stiffening trusses of long spans; possibilities of arrangement in multiple span construction.

BUILDINGS

APARTMENT HOUSES, STEEL. Now Steel Frame Apartments. *Am. Bldr. and Bldg. Age*, vol. 50, no. 4, Jan. 1931, pp. 70–71, 3 figs. Wayne apartments, recently built in Philadelphia suburb, demonstrate practical economy of steel frame system of construction.

CONCRETE, DESIGN. The Aesthetic Side of Structural and Constructional Engineering, H. Robertson. *Structural Engr.*, vol. 9, no. 1, Jan. 1931, pp. 17–18. Discussion by H. Davies of paper indexed in Engineering Index 1930, from issue of Dec. 1930.

Trend in Design of Concrete Buildings During 1930, W. R. Hart. *Contract Rec. (Toronto)*, vol. 44, no. 53, Dec. 31, 1930, pp. 1611–1612, 2 figs. Survey shows that there has been pronounced tendency toward use of higher unit working stresses and high strength concrete; better understanding of design principles and more care in preparation of specifications; revolutionary changes in architecture.

HIGH, NEW YORK. Topping Out the Empire State Building. *Eng. News-Rec.*, vol. 106, no. 4, Jan. 22, 1931, pp. 153–154, 3 figs. Observation tower, 205 ft. high above roof of world's tallest building, reaches to 1,250 ft. above curb; 600 tons of steel erected in two weeks; steel erection was carried out by 15-ton guy derrick which moved steel direct from 86th-floor relay platform to its position in tower; structural details.

HIGH, PLUMBING. Plumbing One Thousand Feet Skyward. *Plumbers Trade Jl.*, vol. 90, no. 1, Jan. 1, 1931, pp. 22, 24, 26, and 27, 7 figs. Additional details of plumbing installed in new Empire State office building; huge tank for house supply; gravity drainage system; sub-basement plan showing piping and location of apparatus; pump unit on 20th floor.

STEEL, WELDED. Design and Fabrication of Oxy-Acetylene Welded Building, H. M. Priest. *Int. Acetylene Assn.—Proc., of mtg.*, Nov. 13–14–15, 1929, pp. 167–179, 12 figs. Previously indexed from Acetylene Jl., Apr. 1930.

CONCRETE

AGGREGATES. Aggregates. *Engineering (Lond.)*, vol. 130, no. 3388, Dec. 19, 1930, pp. 764–766, 3 figs. Position occupied by aggregate in relation to cement and water; review of data available on aggregates for concrete.

AGGREGATES, SPECIFICATIONS. Tentative Specifications for Concrete Aggregates. *Am. Soc. Testing Matls.—Proc.*, vol. 30, part 1, of mtg. June 23–27, 1930, pp. 1022–1026. Previously indexed from Tentative Standards, 1930, p. 176.

BRIDGES, WINTER CONSTRUCTION. Winter Concreting on a Three-Arch Bridge, R. F. Rey. *Eng. News-Rec.*, vol. 105, no. 26, Dec. 25, 1930, pp. 1004–1005, 3 figs. Logan St. viaduct, costing \$425,000 and constructed by city of Lansing, Mich., was concreted in freezing to sub-zero weather, using over-all housing; heated by steam heaters with fan distribution of warm air; expansion joint construction.

CONCRETE CREEP. Studies in Reinforced Concrete; The Creep or Flow of Concrete under Load, W. H. Ganville. *Dept. Sci. and Indus. Research—Tech. Paper (Lond.)*, no. 12, 1930, 39 pp., 27 figs., 3 supp. plates. Report on experimental study which demonstrated that conclusions reached by Faber are correct in substance; relation between creep and applied stress; creep during long periods; influence of constitution and condition of concrete; influence of creep in steel.

CONSTRUCTION FORMS. How to Save in Concrete Form Work, A. B. MacMillan. *Concrete*, vol. 38, no. 1, Jan. 1931, pp. 35–40. Estimation of various formwork parts for definite areas; wall footings; column footings; foundation walls; interior columns; and corner columns; beam and girder sides; beam and girder bottoms; beam and girder floor forms; flat slab floors; concrete floor systems in steel framed buildings; walls above grade; concrete stairs. (Continuation of serial.)

CONSTRUCTION, MATERIALS HANDLING. Piping Used to Unload Finely-Ground Products. *Heat. Piping and Air Conditioning*, vol. 3, no. 1, Jan. 1931, p. 32, 2 figs. Design and operating characteristics of piping system which conveyed concrete for foundations and footings of Merchandise Mart; portland cement also conveyed from ship at dock to hopper 65 ft. high; pumping equipment.

TANKS, DESIGN. Stresses in the Walls of Elevated Cylindrical Tanks of Reinforced Concrete, J. A. Fargher. *Instn. Engrs. Australia—Jl.*, vol. 2, no. 12, Dec. 1930, pp. 445–454, 15 figs. Theoretical mathematical analysis of stresses caused by hydrostatic loads in walls of cylindrical tanks; example showing how conclusion may be applied in practice; stresses in triangular walls and in tower walls are examined.

VOLUME CHANGES. Volume Change of Concrete, C. H. Scholer and E. R. Dawley. *Am. Soc. Testing Matls.—Proc.*, vol. 30, pt. 2, June 23–27, 1930, pp. 751–766, 12 figs. Reason for apparent difference in number and character of shrinkage cracks in those concrete pavements made of cement and aggregate containing very little coarse aggregate, compared with cracks in pavements made of concrete containing customary proportion of coarse aggregate; apparatus which was developed for measuring expansion and contraction of concrete specimens.

WORKABILITY. Further Studies on the Workability of Concrete, W. F. Purrington and H. C. Loring. *Am. Soc. Testing Matls.—Proc.*, vol. 30, pt. 2, June 23–27, 1930, pp. 654–667 and (discussion) 668–673, 12 figs. Investigation of determination of workability of concrete by measuring power consumed in mixing concrete; subject is approached from laboratory and economic viewpoint.

DAMS

CONCRETE ARCH, DESIGN. Arch Dam Analysis by Trial Loads Simplified, H. M. Westergaard. *Eng. News-Rec.*, vol. 106, no. 4, Jan. 22, 1931, pp. 141–143, 2 figs. Essential steps for determining stresses in dams where vertical and horizontal resistances are jointly in action; method, developed by engineers of Bureau of Reclamation known as trial-load method; analysis based on

Artist's conception of Barbara Frietchie's Home in Frederick, Maryland

gradual approach by trial; trial loads are modified so that conditions of geometrical continuity are finally satisfied; radial adjustment; tangential adjustment; influence of Poisson's ratio; convergence of adjustments.

CONCRETE, CONSTRUCTION. Felling a Dam in Canada. *Engineer (Lond.)*, vol. 150, no. 3909, Dec. 12, 1930, p. 649. In developing Saguenay River, at Chute-a-Caron, Quebec, it was necessary to divert flow through artificial cut while main dam was built; this cut had subsequently to be closed, and expedient adopted was to build closing dam in vertical direction to completion and then to topple it over into channel.

CONCRETE, EGYPT. The Nag Hamadi Barrage. *Engineering*, vol. 131, no. 3390, Jan. 2, 1931, pp. 20–22, 8 figs. partly on p. 16. Dam, below Luxor in Egypt, is latest of series of works built across River Nile to provide greater facilities for irrigation in Upper Egypt and better water supply; length between abutment piers is 2,698 ft.; total length, including lock at western end, is 2,885 ft.; comprises two abutments, nine main piers, and 90 intermediate piers; gates are operated by hand, machinery for this purpose being housed in pits formed in decking of side walls; beginning was made by constructing sudd, or temporary dam, of steel sheet piling round area for first season's work.

DESIGN. Some New Ideas on Dams, E. Godfrey. *Structural Engr.*, vol. 9, no. 1, Jan. 1931, pp. 11–17, 1 fig. Discussion of failures of dams, with special reference to underpressure; plugging up leaks; erosion of soil; St. Francis dam failure; blow-outs in dams; design of dams will not be on sound basis until engineers recognize underpressure is as important as pressure of water on upstream face of dam.

EARTH, FAILURE. Engineers Report On the Failure of the Corpus Christi Dam, H. E. Elrod and R. J. Cummins. *Eng. News-Rec.*, vol. 106, no. 4, Jan. 22, 1931, pp. 163 and 165. Abstract of report of engineers; dam can be repaired; percolation had been proceeding for months before final failure occurred; no evidence of earthquake.

HOOVER DAM. Hoover Dam Plans Ready for Bidding. *Eng. News-Rec.*, vol. 105, no. 26, Dec. 25, 1930, pp. 1011–1017, 7 figs. Structure to be built of grouted columnar units with embedded refrigeration system to control shrinkage and thermal changes; proposals for entire work are under single contract covering seven-year construction period; dam is concrete gravity-section structure, 730 ft. high, 1,180 ft. long on crest, built in form of arch of 500-ft. radius; spillway details; details of specifications; methods of building dam; diagrammatic sketch of contraction joints.

FLOOD CONTROL

LEVEES, CONSTRUCTION. Earthwork 73 Per Cent Complete on Dallas Levee Project. *Eng. News-Rec.*, vol. 106, no. 4, Jan. 22, 1931, p. 158, 2 figs. Progress report on earthwork involved in construction of Dallas Levee Improvement District; 11,926,770 cu. yd., or 73 per cent, had been placed by October.

MISSISSIPPI RIVER. Flood Control on Alluvial Rivers, T. H. Jackson. *Eng. News-Rec.*, vol. 106, no. 3, Jan. 15, 1931, pp. 105–108, 2 figs. Definition and appraisal of methods; levees, reservoirs, diversions, and minor method of dredging and shortening; clearing and reforestation; levee and diversion system of Mississippi flood protection approved May 15, 1928; detention reservoir system for protection of cities of Miami River valley in Ohio; clearing methods. (To be concluded.)

Flood Control on Alluvial Rivers, T. H. Jackson. *Eng. News-Rec.*, vol. 106, no. 4, Jan. 22, 1931, pp. 144–148, 4 figs. Flood-control works on Mississippi; levee design and structure; bank protection by revetment; articulated concrete block revetment; lapped-slab concrete revetment frequently used for upper-bank paving; spillway types and structures; other control structures. (Concluded.)

FLOW OF FLUIDS

CURVED CHANNELS. Hydraulic Characteristics of Flow of Water. *Eng. News-Rec.*, vol. 106, no. 2, Jan. 8, 1931, p. 82. Discussion by E. M. Shepherd of paper indexed in Engineering Index 1930, from issue of Sept. 4, 1930.

RESISTANCE. Resistance of Thin, Longitudinally Streamed, Smooth Plates at High Reynolds Coefficients—A Semi-Empirical Study (Der Wilderstand von duennen, laengs angestroemten glatten Platten bei hohen Reyonds'schen Zahlen—eine half-empirische Betrachtung), F. Eisner. *Schiffbau (Berlin)*, vol. 31, no. 22, Nov. 15, 1930, pp. 563–567, 5 figs. Discussion deals only with field of such high Reynolds figures that turbulence is surely present in boundary layer; influence of curve of plate on longitudinal edge resistance and specific resistance of very long plate.

MATERIALS TESTING

BRICK, CONSTRUCTION. Tests Seek to Develop Designs for Reinforced Brickwork, H. Filippi. *Brick and Clay Rec.*, vol. 78, no. 1, Jan. 13, 1931, pp. 27–32 and 34, 8 figs. Report on original tests by Common Brick Manufacturers Assn.; brick masonry combined with correct steel reinforcement is found to resist tensile stresses; 24 beams and slabs tested were reinforced with $^3/_8$-in. straight corrugated round bars; comparative data on reinforced brickwork beams and slabs; all beams developed diagonal tension cracks and ultimately failed in bond; deflection curves; immediate introduction of reinforced brickwork, in spite of its possibilities, is not justified.

CEMENT TESTING MACHINES. Strength Testing Machines (Festigkeits Pruefmaschinen). *Tonindustrie Zeitung (Berlin)*, vol. 54, no. 99, Dec. 11, 1930, pp. 1541–1542, 1 fig. Extract from supplement to German tentative specifications for portland cement, iron portland cement, and blast-furnace cement; tensile and compressive-strength testing machines.

CONCRETE. A Study of the Flow-Table and the Slump Test, G. A. Smith and S. W. Benham. *Am. Concrete Inst.—Jl.*, vol. 2, no. 5, Jan. 1931, pp. 420–438, 9 figs. Report on experimental study which involved making of 300 slump tests and 450 determinations of flow and testing of 300 compression specimens; relation between slump and total water used for various mixes; relation between flow and total water; relation between relative cement content of mix and quantity of water required for given flows; relation between flow and slump; relation between water cement ratio and compressive strength.

Relation Between Durability of Concrete and Durability of Aggregates, F. H. Jackson. *Crushed Stone Jl.*, vol. 6, no. 12, Dec. 1930, pp. 3–9 and 22. Report prepared for committee on aggregates, Highway Research Board; general discussion, including suggested outlines of research along lines commented upon; thermal expansion; sodium sulfate soundness test. Bibliography.

Suggested Procedure for Testing Concrete in Which the Aggregate Is More Than One-Fourth the Diameter of the Cylinders, F. R. McMillian. *Am. Soc. Testing Matls.—Proc.*, vol. 30, part 1, of mtg. June 23–27, 1930, pp. 521–535. Previously indexed from Advance Paper, no. 59.

ROADS AND STREETS

CONCRETE, CONSTRUCTION. Two Pavers in Tandem. *Construction Methods*, vol. 13, no. 1, Jan. 1931, pp. 44–47, 13 figs. Two unconnected paving mixers operated in tandem, each doing approximately half mixing of every batch, attained production 60 per cent greater than that reached by either when operated alone, on 38 $^1/_2$-mi. concrete-road job between Springfield and Louisburg, Mo.; location plant and order of paving operations.

CONCRETE, MAINTENANCE, AND REPAIR. Settled Concrete Road Slabs Lifted and Leveled by Force Pump. *Concrete*, vol. 38, no. 1, Jan. 1931, p. 27, 1 fig. In Iowa, settled concrete pavement slabs are being raised and leveled up by pumping mixture of loam, cement, and water under them, through holes in slab; road slabs raised as much as 16 in. by this method; not necessary to detour traffic while slab is being raised, as only half pavement is lifted at time.

CONCRETE, RESURFACING. Bituminous Wearing Surfaces for Concrete Roads, W. H. Sharp. *Contract Rec. (Toronto)*, vol. 44, no. 52, Dec. 24, 1930, pp. 1579–1580. Conditions determining types of materials to use; experiments with various mixes; methods of protecting edges.

CONSTRUCTION, LOS ANGELES. Secondary Residential Street Becomes Metropolitan Business Artery, H. P. Cortelyou. *West. City*, vol. 7, no. 1, Jan. 1931, pp. 27–30, 6 figs. Widening, re-alignment, paving, and lighting of Eighth Street in Los Angeles; sewers behind curb line; principal quantities and unit process.

CONSTRUCTION, SASKATCHEWAN. Ten Million Dollars for Roads in Saskatchewan, H. S. Carpenter. *Contract Rec. (Toronto)*, vol. 44, no. 53, Dec. 31, 1930, pp. 1657–1658. Details of expenditure; trunk highway system established; route of trunk roads; 1,075 miles of grading and 1,100 miles of graveling bridges; reorganization of department; maintenance work reorganized; relief road work.

SEWERAGE AND SEWAGE DISPOSAL

ACTIVATED SLUDGE, COLLINGSWOOD, N.J. Activated Sludge Plant Using Mechanical Aeration, W. D. Vosburg and P. B. Streander. *Pub. Works*, vol. 62, no. 1, Jan. 1931, pp. 26–27 and 62–64, 5 figs. Preliminary settling, new type of mechanical aerator, and separate digestion constitute features of treatment plant at Collingswood, N.J., which was designed for capacity of 2,000,000 gal. per day.

COSTS. Cost of Sewage Treatment at Worcester, Mass. *Water Works and Sewerage*, vol. 77, no. 12, Dec. 1930, pp. 433–434. Details and cost data of plant having daily capacity of 28 million gallons, including data on grit chamber cleaning, Imhoff tanks, trickling filters, secondary settling tanks, and sludge disposal.

DIGESTION METHOD. Thermophilic Digestion of Sewage Solids, W. Rudolfs and H. Heukelekian. *Indus. and Eng. Chem.*, vol. 23, no. 1, Jan. 1931, pp. 67–69, 1 fig. Daily editions of sewage solids, both fresh and activated, have been digested at thermophilic temperatures (50 deg. cent.) in as short time as 2.1 days; sludge produced was black, had no odor other than tarry odor of ripe sludge; and had bio-chemical oxygen demand corresponding to ripe sludge; gentle shaking, to bring raw solids in contact with seed material, proved beneficial; preheating of sludge is probably best and ripe sludge can be dewatered continuously.

WATER PIPE LINES

SIPHONS, SUBAQUEOUS. Repairs Inside 54-In. Steel Water Pipe Made Under Pressure, J. S. Longwell. *Eng. News-Rec.*, vol. 106, no. 3, Jan. 15, 1931, pp. 100–111, 3 figs. Method of inspecting East Bay Municipal Utility District's San Joaquin River siphon, about 600 ft. long, consisting of two steel pipes, each 54 in. in diam.; pipe interior examined by use of sliding air lock which consisted of two wooden bulkheads, 9 ft. apart, connected by 4-in. × 6-in. timbers; circular bulkheads made up in two parts, lower half attached to framework and upper half hinged allowing chamber to be moved inside pipe to permit diver to enter and leave.

STEEL. Steel Trunk Lines with Bell and Spigot Joints, W. W. Hurlbut. *Am. Water Works Assn.—Jl.*, vol. 22, nos. 9 and 12, Sept. 1930, pp. 1178–1181 and (discussion) 1181–1188, and Dec., pp. 1669–1672. Practice of Los Angeles Water Department, since 1905, with riveted and welded steel pipe with bell and spigot joints; cost data. Paper presented before St. Louis Convention June 4, 1930.

WATER TREATMENT

FILTRATION PLANTS, FLOCCULATION. Watch for Flocculated Matter Passing the Filter Beds, J. R. Baylis. *Water Works and Sewerage*, vol. 77, no. 12, Dec. 1930, pp. 417–420, 1 fig. Character of flocculated matter that passes filters; causes for weakness of coagulated matter; filters will not handle high flocculated turbidity; compacting of flocculated matter in sand beds; fine sand filtering of flocculated matter; objections to flocculated matter passing filter beds; how to detect flocculated turbidity; plant results show need of floc detectors on every filter.

FILTRATION PLANTS, LONDON. Purification of London's Water, S. Walker. *Surveyor*, vol. 79, no. 2032, Jan. 2, 1931, pp. 9 and (discussion) 9–12. Report on first year's operation of Kempton Park primary filters; filtering medium; cleaning and construction; results of double filtration; working of strainers; sludge pumps and sludge beds; bacteriological results; quantity of wash water. Abstract of paper presented before Instn. Water Engrs., Dec. 5, 1930.

WATER WORKS ENGINEERING

AQUEDUCTS, COLORADO RIVER. Colorado River Aqueduct Route Selected for Metropolitan Water District of Southern California. *West. Construction News*, vol. 6, no. 1, Jan. 10, 1931, pp. 21–22 and 44, 1 fig. Data on route, delivery, and pumping lifts; estimated construction cost; features of rejected routes; basis of selection; status of project.

DEEP WELLS. Deep Well Developments in Southern California, D. A. Lane. *Water Works and Sewerage*, vol. 77, no. 12, Dec. 1930, pp. 430–432, 2 figs. Report on Los Angeles auxiliary well system and method adopted for preventing interference; types of wells now in vogue; logs of wells; perforation of wells; methods of development; development of wells with air; amount of development necessary. Abstract of paper presented before Am. Water Works Assn.

IRON AND STEEL PLANTS. Water-Supply of a Steel Plant, T. J. McLoughlin. *Engrs.' Soc. West. Penn.—Proc.*, vol. 46, no. 9, Nov. 1930, pp. 295–303 and (discussion), 303–305. Design of intake and other parts of water supply systems for large steel plants; it takes 14,000 to 17,000 gal. of water to produce one ton of steel; river acidity; blast furnace requirements; open-hearth requirements; blooming mill and billet mill requirements; condenser requirements; boiler feedwater; water requirements of typical steel plant.

OPERATORS. The Round Table. *Water Works*, vol. 84, *Eng.*, no. 1, Jan. 14, 1931, pp. 27–28 and 62. Practical discussion of operation of schools for training water-plant operators; suggestions for making these schools of greater value.